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

In [3]:
```
data = pd.read_csv("Downloads/advertising.csv")
data
```

Out[3]:

| | TV | Radio | Newspaper | Sales |
|---|---|---|---|---|
| **0** | 230.1 | 37.8 | 69.2 | 22.1 |
| **1** | 44.5 | 39.3 | 45.1 | 10.4 |
| **2** | 17.2 | 45.9 | 69.3 | 12.0 |
| **3** | 151.5 | 41.3 | 58.5 | 16.5 |
| **4** | 180.8 | 10.8 | 58.4 | 17.9 |
| **...** | ... | ... | ... | ... |
| **195** | 38.2 | 3.7 | 13.8 | 7.6 |
| **196** | 94.2 | 4.9 | 8.1 | 14.0 |
| **197** | 177.0 | 9.3 | 6.4 | 14.8 |
| **198** | 283.6 | 42.0 | 66.2 | 25.5 |
| **199** | 232.1 | 8.6 | 8.7 | 18.4 |

200 rows × 4 columns

In [4]:
```
data.shape
```

Out[4]:
```
(200, 4)
```

In [5]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   TV         200 non-null    float64
 1   Radio      200 non-null    float64
 2   Newspaper  200 non-null    float64
 3   Sales      200 non-null    float64
dtypes: float64(4)
memory usage: 6.4 KB
```

In [6]:
```
data.describe()
```

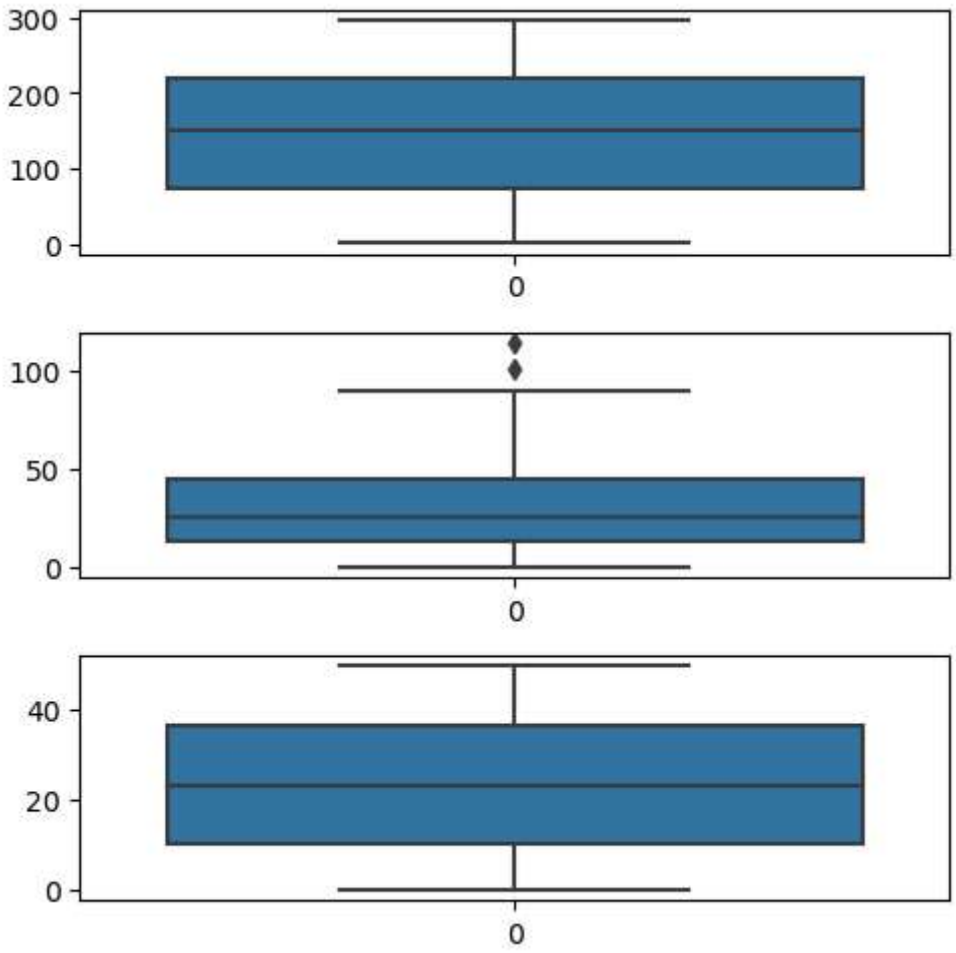
Out[6]:

| | TV | Radio | Newspaper | Sales |
|---|---|---|---|---|
| **count** | 200.000000 | 200.000000 | 200.000000 | 200.000000 |
| **mean** | 147.042500 | 23.264000 | 30.554000 | 15.130500 |
| **std** | 85.854236 | 14.846809 | 21.778621 | 5.283892 |
| **min** | 0.700000 | 0.000000 | 0.300000 | 1.600000 |
| **25%** | 74.375000 | 9.975000 | 12.750000 | 11.000000 |
| **50%** | 149.750000 | 22.900000 | 25.750000 | 16.000000 |
| **75%** | 218.825000 | 36.525000 | 45.100000 | 19.050000 |
| **max** | 296.400000 | 49.600000 | 114.000000 | 27.000000 |

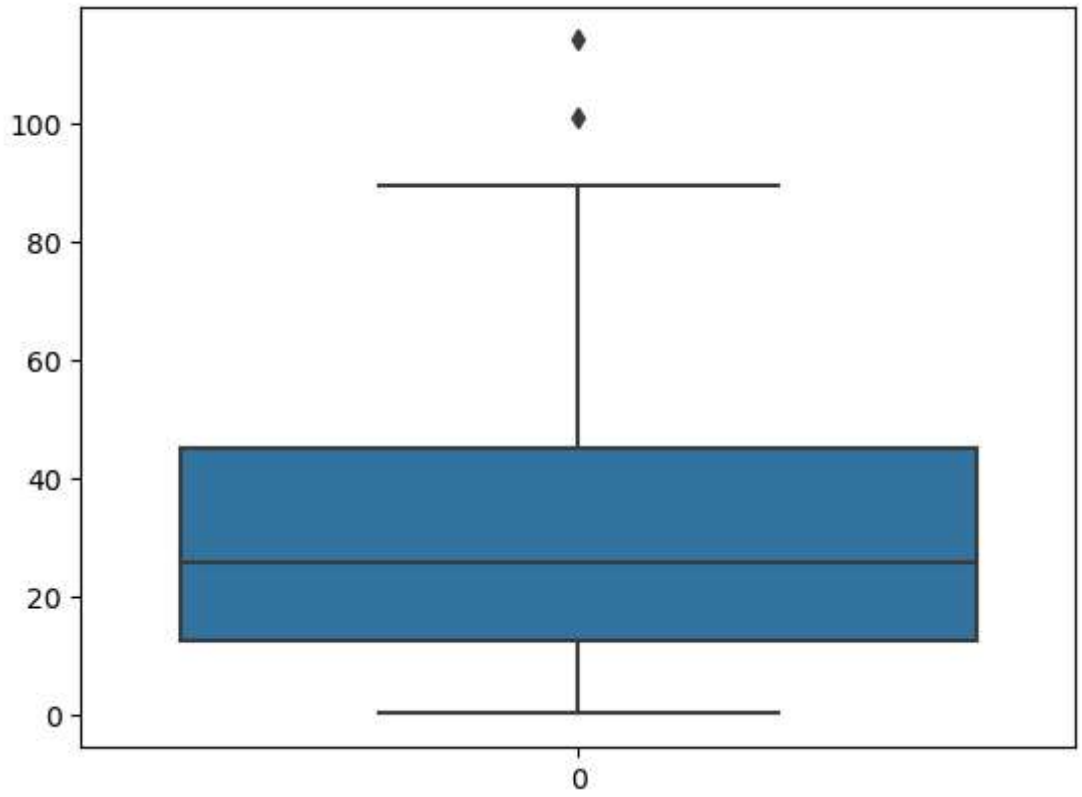
In [7]:
```
data.isnull().sum()*100/data.shape[0]
```

Out[7]:
```
TV           0.0
Radio        0.0
Newspaper    0.0
Sales        0.0
dtype: float64
```

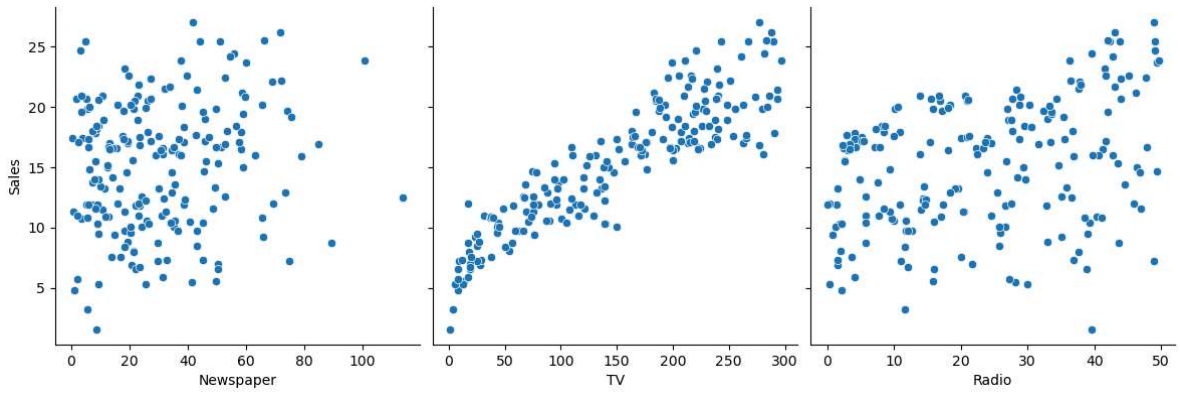
In [8]:
```
fig, axs = plt.subplots(3, figsize=(5,5))
plt1 = sns.boxplot(data['TV'], ax =axs[0])
plt2 = sns.boxplot(data['Newspaper'], ax = axs[1])
plt3 = sns.boxplot(data['Radio'], ax= axs[2])
plt.tight_layout()
```



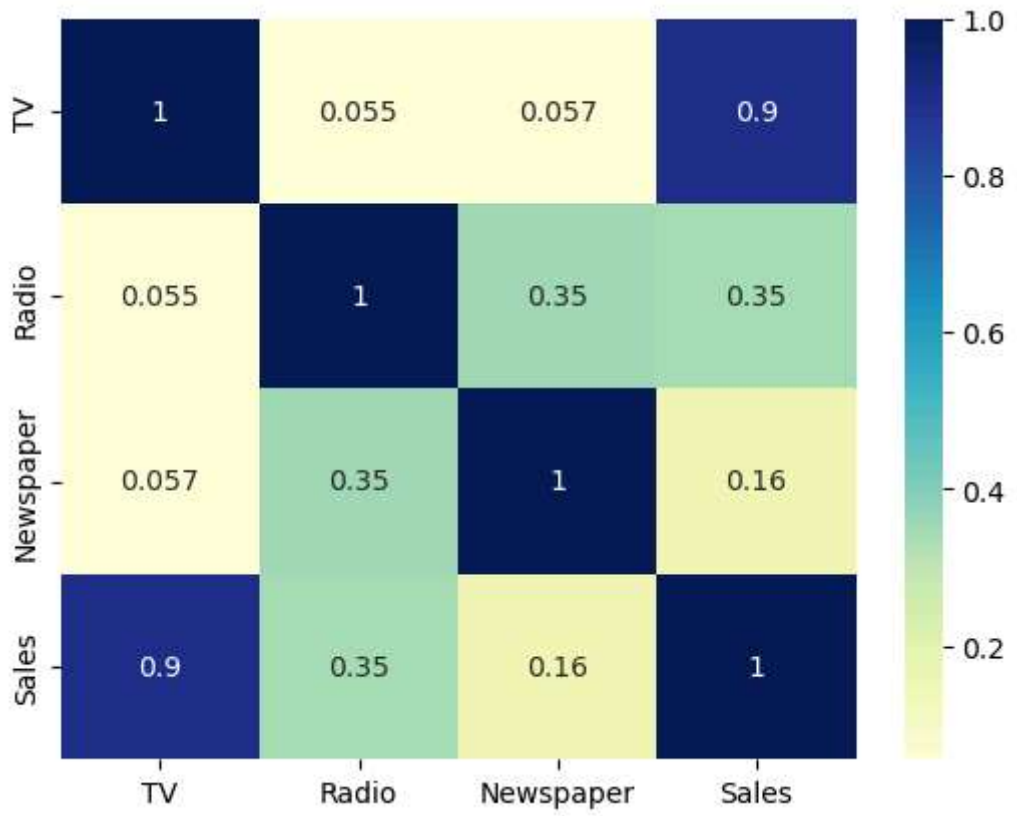
In [9]:
```
sns.boxplot(data['Newspaper'])
plt.show()
```




In [10]:
```
sns.pairplot(data, x_vars = ['Newspaper', 'TV', 'Radio'], y_vars ='Sales' , he
plt.show()
```



In [11]:
```
sns.heatmap(data.corr(), cmap="YlGnBu", annot = True)
plt.show()
```




In [12]:
```
x = data['TV']
Y = data['Sales']
```

In [13]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, Y_train, Y_test = train_test_split(x,Y, test_size=0.3, random
```

In [14]:
```
x_train.head()
```

Out[14]:
```
74     213.4
3      151.5
185    205.0
26     142.9
90     134.3
Name: TV, dtype: float64
```

In [15]:
```
Y_train.head()
```

Out[15]:
```
74     17.0
3      16.5
185    22.6
26     15.0
90     14.0
Name: Sales, dtype: float64
```

In [16]:
```
import statsmodels.api as sm
x_train_sm = sm.add_constant(x_train)
lr = sm.OLS(Y_train, x_train_sm).fit()
```

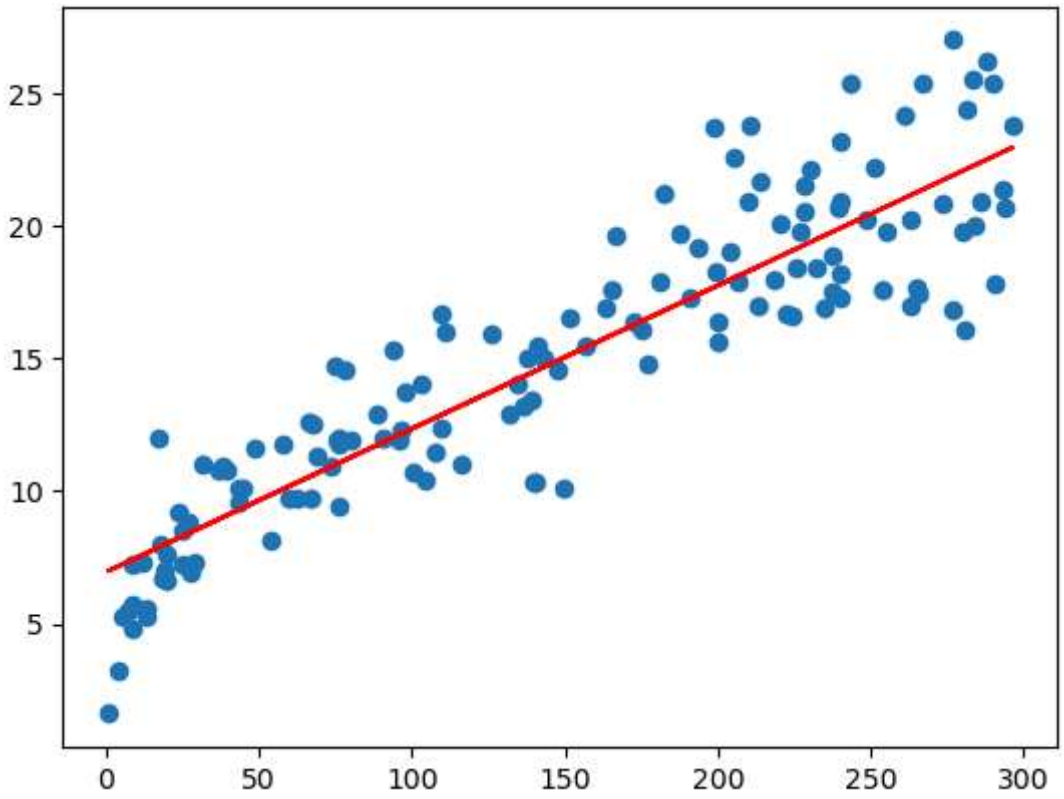
In [17]:
```
lr.params
```

Out[17]:
```
const    6.948683
TV       0.054546
dtype: float64
```

In [18]:
```
print(lr.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  Sales   R-squared:                       0.81
6
Model:                            OLS   Adj. R-squared:                  0.81
4
Method:                 Least Squares   F-statistic:                     611.
2
Date:                Mon, 23 Sep 2024   Prob (F-statistic):           1.52e-5
2
Time:                        19:16:47   Log-Likelihood:                -321.1
2
No. Observations:                 140   AIC:                             646.
2
Df Residuals:                     138   BIC:                             652.
1
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.97
5]
------------------------------------------------------------------------------
-
const          6.9487      0.385     18.068      0.000       6.188       7.70
9
TV             0.0545      0.002     24.722      0.000       0.050       0.05
9
==============================================================================
Omnibus:                        0.027   Durbin-Watson:                   2.19
6
Prob(Omnibus):                  0.987   Jarque-Bera (JB):                0.15
0
Skew:                          -0.006   Prob(JB):                        0.92
8
Kurtosis:                       2.840   Cond. No.                         32
8.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correc
tly specified.
```

In [19]:
```
plt.scatter(x_train, Y_train)
plt.plot(x_train, 6.948 + 0.054*x_train, 'r')
plt.show()
```

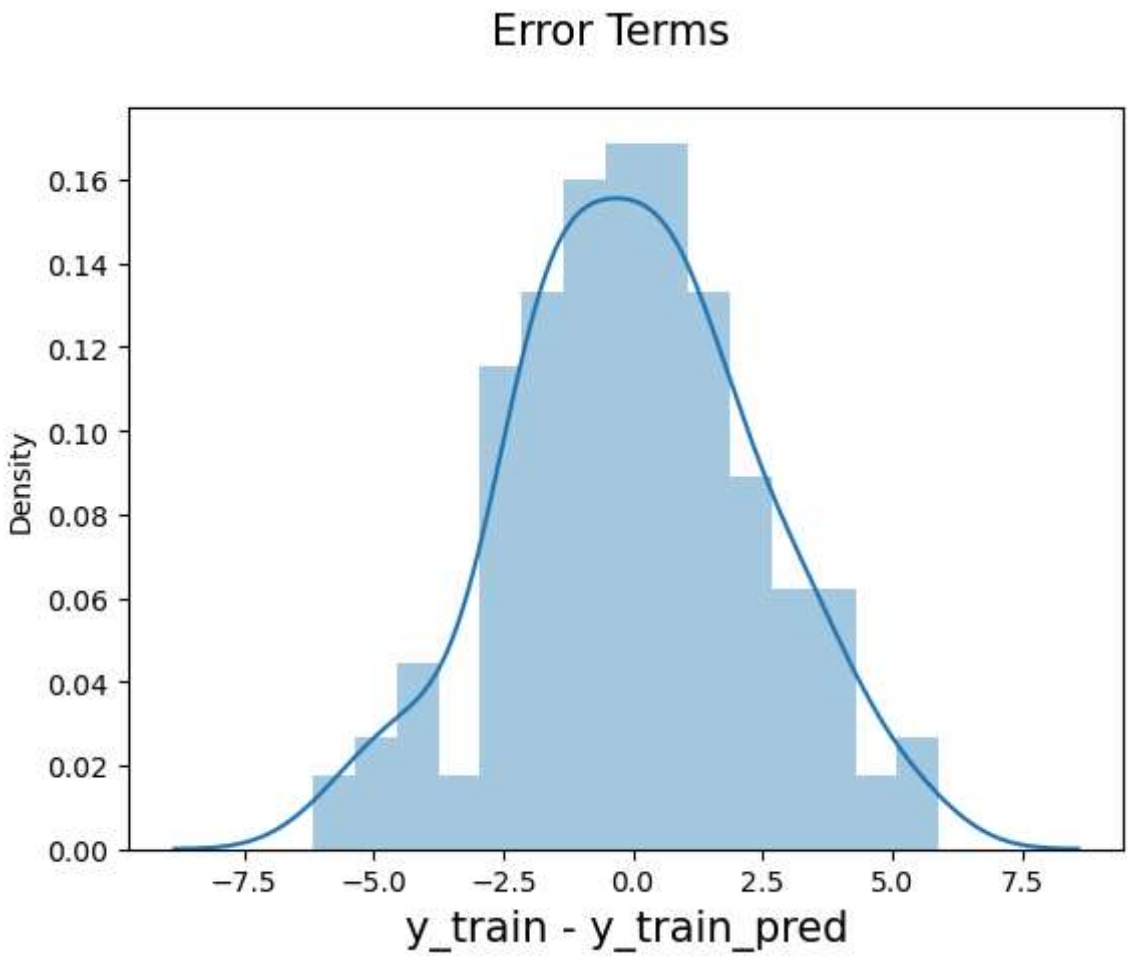



In [20]:
```
pred = lr.predict(x_train_sm)
res = (Y_train - pred)
pred
```

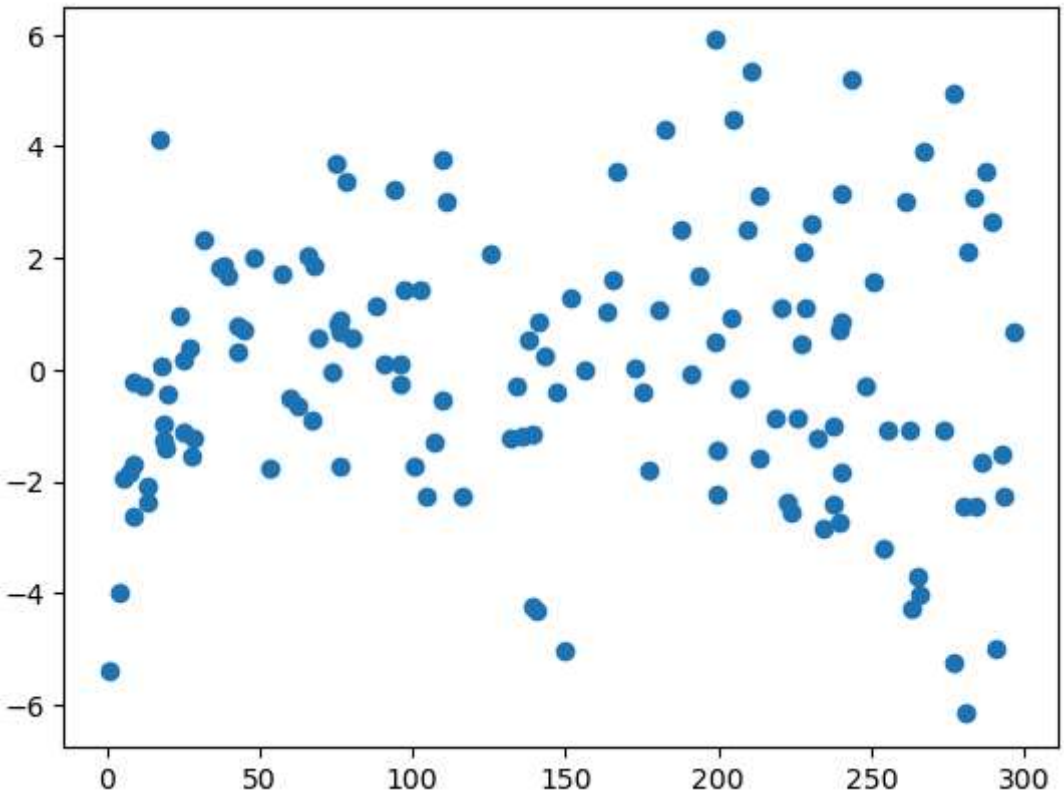
Out[20]:
```
74     18.588747
3      15.212365
185    18.130563
26     14.743271
90     14.274178
         ...
87     12.986898
103    17.197830
67     14.546907
24     10.346884
8       7.417777
Length: 140, dtype: float64
```

In [21]:
```
fig = plt.figure()
sns.distplot(res, bins = 15)
fig.suptitle('Error Terms', fontsize = 15)
plt.xlabel('y_train - y_train_pred', fontsize = 15)
plt.show()
```

```
C:\Users\Mano\AppData\Local\Temp\ipykernel_17716\3086354427.py:2: UserWarnin
g:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751 (https://gis
t.github.com/mwaskom/de44147ed2974457ad6372750bbe5751)

  sns.distplot(res, bins = 15)
```



In [22]:
```
plt.scatter(x_train, res)
plt.show()
```




In [23]:
```
x_test_sm = sm.add_constant(x_test)
y_pred = lr.predict(x_test_sm)
y_pred.head()
```

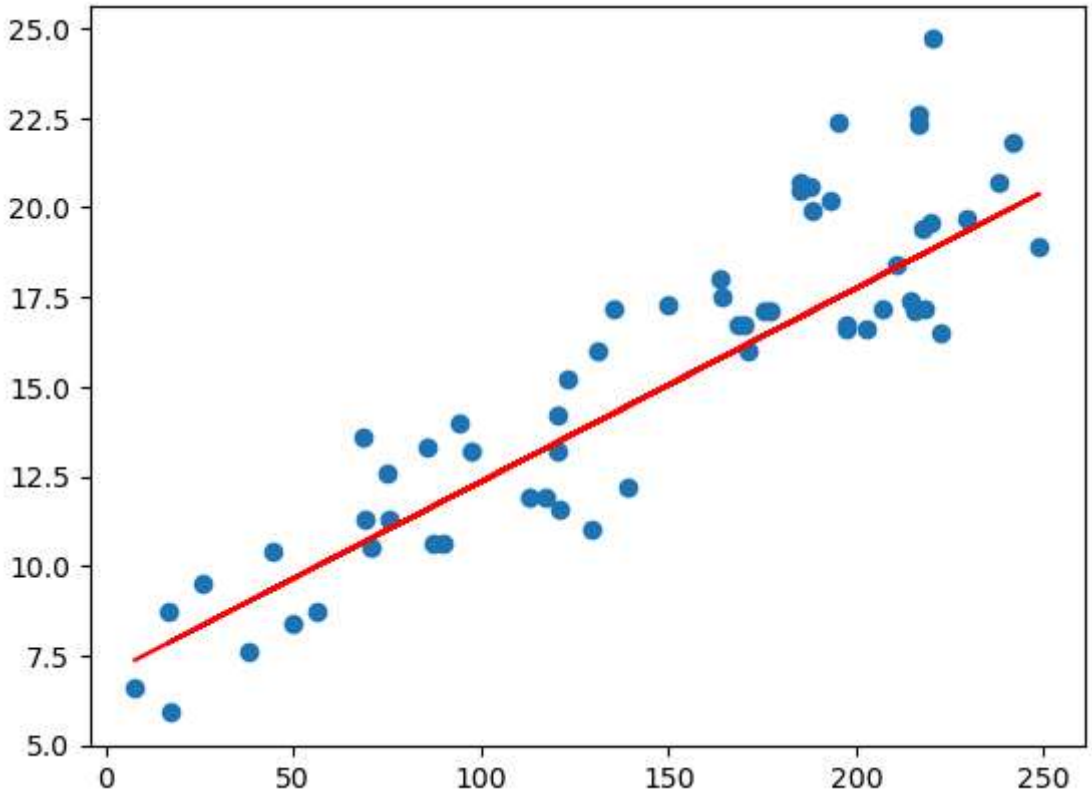
Out[23]:
```
126     7.374140
104    19.941482
99     14.323269
92     18.823294
111    20.132392
dtype: float64
```

In [24]:
```
from sklearn.metrics import mean_squared_error , r2_score
print("The Mean Squared error :" ,np.sqrt(mean_squared_error(Y_test,y_pred)))
print("The R2 score is :" ,r2_score(Y_test,y_pred) )
```

```
The Mean Squared error : 2.019296008966233
The R2 score is : 0.7921031601245658
```

In [25]:
```
plt.scatter(x_test, Y_test)
plt.plot(x_test, 6.948 + 0.054 * x_test,'r')
plt.show
```

Out[25]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```




In [ ]:
```
```