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Batch : C32

Roll No : 1902101

In [31]:
```python
# Importing Libraries

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
```

In [32]:
```python
# Displaying the Dataset

dataset = pd.read_csv('tvmarketing.csv')
dataset
```
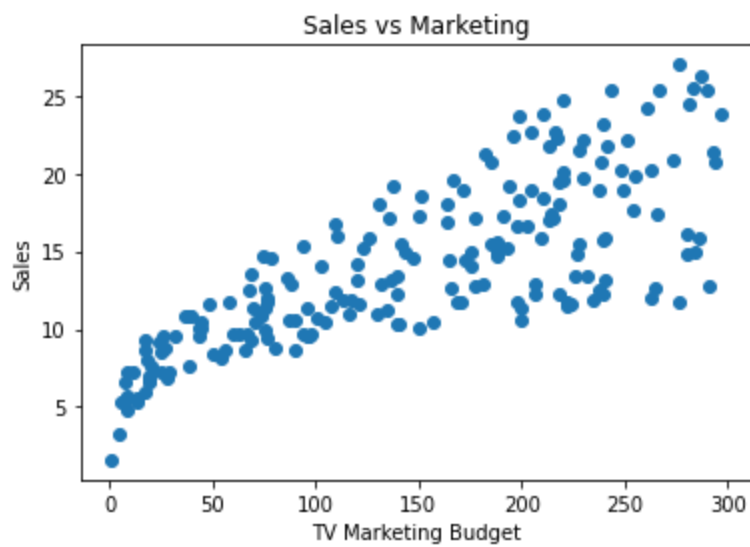
Out[32]:

	TV	Sales
0	230.1	22.1
1	44.5	10.4
2	17.2	9.3
3	151.5	18.5
4	180.8	12.9
...	...	...
195	38.2	7.6
196	94.2	9.7
197	177.0	12.8
198	283.6	25.5
199	232.1	13.4

200 rows × 2 columns

In [33]:
```python
# Visualizing data using Scatterplot

X = dataset['TV']
y = dataset['Sales']
plt.scatter(X,y)
plt.title('Sales vs Marketing')
plt.xlabel('TV Marketing Budget')
plt.ylabel('Sales')
plt.show()
```

Sales vs Marketing

```
# Split dataset into train and test set

X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=13)
X_train
```

```
125      87.2
68      237.4
69      216.8
108      13.1
131     265.2
         ...
98      289.7
16       67.8
74      213.4
176     248.4
82       75.3
Name: TV, Length: 160, dtype: float64
```

Simple Linear Regression - Analytical Method

```
# Simple Linear Regression - Analytical Method - Train and Test

def calculate_b1(X,y):
    return np.dot((X-np.mean(X)),(y-np.mean(y)))/np.sum(np.square(X-np.mean(X)));

def calculate_b0(X,y,b1):
    return (np.mean(y) - (b1*np.mean(X)))

def predict(X,b0,b1):
    return (b0 + (b1*X))

b1 = calculate_b1(X_train,y_train)
b0 = calculate_b0(X_train,y_train,b1)
print('B0 (intercept) = ',b0)
print('B1 (slope) = ',b1)

y_pred_analytical = predict(X_test,b0,b1)

results = pd.DataFrame({'Actual':y_test,'Analytical':y_pred_analytical})
results
```

```
B0 (intercept) =  7.230328663758761
B1 (slope) =  0.04634776283125915
```

Actual	Analytical

	Actual	Analytical
179	12.6	14.905518
155	3.2	7.420354
23	15.5	17.811523
159	12.9	13.334329
96	11.7	16.388647
198	25.5	20.374554
42	20.7	20.838032
110	13.4	17.695654
128	24.7	17.440741
97	15.5	15.800030
95	16.9	14.798918
106	7.2	8.389023
65	9.3	10.428324
33	17.4	19.540294
102	14.8	20.216972
89	16.7	12.319313
132	5.7	7.619650
79	11.0	12.606669
104	20.7	18.270366
70	18.3	16.458168
173	11.7	15.035292
129	9.7	9.992655
30	21.4	20.805588
7	13.2	12.801330
168	17.1	17.213637
124	19.7	17.867140
157	10.1	14.173224
165	11.9	18.098879
101	23.8	20.967806
78	5.3	7.480607
87	16.0	12.361026
141	19.2	16.207890
105	19.2	13.621685
10	8.6	10.293916
64	18.0	13.306520
13	9.7	11.749236

	Actual	Analytical
90	11.2	13.454833
15	22.4	16.286682
195	7.6	9.000813
94	11.5	12.208078

In [36]:
```python
# Simple Linear Regression - Analytical Method - Prediction

X_ip = float(input('Enter value of marketing budget : '))
print('Predicted Sales value is : ',predict(X_ip,b0,b1))
```

```
Enter value of marketing budget : 40.5
Predicted Sales value is :  9.107413058424756
```

In [37]:
```python
# Simple Linear Regression - Analytical Method - Regression Line

plt.figure(figsize=(5, 4))
ax = plt.axes()
ax.scatter(X,y)
ax.plot(X,predict(X,b0,b1),color='red')
plt.title('Regression Line - Analytical Method')
ax.set_xlabel('TV Marketing Budget')
ax.set_ylabel('Sales')
plt.show()
```
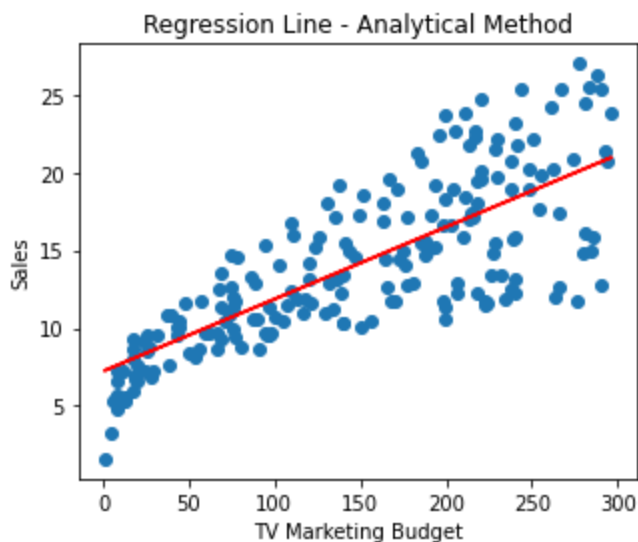

Interpretation of Results : Thus the relationship between marketing and sales is positive and for every 1 unit of increase in marketing budget, the sales increases by b1 = 0.0463

Simple Linear Regression - SGD Method

In [38]:
```python
# Displaying X and Y values used for training

print('X')
print(X_train)
print()
print('Y')
print(y_train)
```

X

```
125      87.2
68      237.4
69      216.8
108      13.1
131     265.2
          ...
98      289.7
16       67.8
74      213.4
176     248.4
82       75.3
Name: TV, Length: 160, dtype: float64

Y
125      10.6
68       18.9
69       22.3
108       5.3
131      12.7
          ...
98       25.4
16       12.5
74       17.0
176      20.2
82       11.3
Name: Sales, Length: 160, dtype: float64
```

In [39]:
```python
# Initialize parameters b0, b1

b0 = 0
b1 = 0
```

In [40]:
```python
# Calculate cost function

def calculate_cost(y,y_pred):
    return np.sum(np.square(y-y_pred))
```

In [41]:
```python
# Calculate gradient of cost function

def calculate_gradient(X,y,y_pred):
    db0 = (-2)*(np.sum(y-y_pred))
    db1 = (-2)*(np.dot(X,y-y_pred))
    return db0,db1
```

In [42]:
```python
# Simple Linear Regression - SGD

def predict(X,b0,b1):
    return (b0 + (b1*X))

def fit(X,y,b0=0,b1=0,learning_rate=0.00001,epochs=2):
    b0 = 0
    b1 = 0
    cost = []
    for epoch in range(1,epochs+1):
        count = 0
        for i in X.index:
            y_pred = predict(X[i],b0,b1)
            y_actual = y[i]
            J = calculate_cost(y_actual,y_pred)
            cost.append(J)
            print('Epoch: ',epoch,', Iteration: ',count+1,', Cost Function Value (J) = ',
```

```
                db0,db1 = calculate_gradient(X[i],y_actual,y_pred)
                b0 = b0 - (learning_rate*db0)
                b1 = b1 - (learning_rate*db1)
                count = (count+1)%len(X)
        return b0,b1,cost


 b0,b1,cost = fit(X_train,y_train,b0,b1)
```

```
Epoch:  1 ,  Iteration:   1 ,  Cost Function Value (J) =   112.36
Epoch:  1 ,  Iteration:   2 ,  Cost Function Value (J) =   210.5725061396848
Epoch:  1 ,  Iteration:   3 ,  Cost Function Value (J) =   11.251934700479284
Epoch:  1 ,  Iteration:   4 ,  Cost Function Value (J) =   15.714485766440342
Epoch:  1 ,  Iteration:   5 ,  Cost Function Value (J) =   213.39001487441027
Epoch:  1 ,  Iteration:   6 ,  Cost Function Value (J) =   244.58245087532657
Epoch:  1 ,  Iteration:   7 ,  Cost Function Value (J) =   6.798992300580298
Epoch:  1 ,  Iteration:   8 ,  Cost Function Value (J) =   7.655698842229168
Epoch:  1 ,  Iteration:   9 ,  Cost Function Value (J) =   48.1211301450999
Epoch:  1 ,  Iteration:   10 ,  Cost Function Value (J) =   6.147482116431189
Epoch:  1 ,  Iteration:   11 ,  Cost Function Value (J) =   7.380388811805911
Epoch:  1 ,  Iteration:   12 ,  Cost Function Value (J) =   12.717258793809124
Epoch:  1 ,  Iteration:   13 ,  Cost Function Value (J) =   34.65924465389198
Epoch:  1 ,  Iteration:   14 ,  Cost Function Value (J) =   56.34761387915064
Epoch:  1 ,  Iteration:   15 ,  Cost Function Value (J) =   19.80997718747628
Epoch:  1 ,  Iteration:   16 ,  Cost Function Value (J) =   30.498999466273176
Epoch:  1 ,  Iteration:   17 ,  Cost Function Value (J) =   6.15552299519198
Epoch:  1 ,  Iteration:   18 ,  Cost Function Value (J) =   33.62488269983432
Epoch:  1 ,  Iteration:   19 ,  Cost Function Value (J) =   18.31779586801466
Epoch:  1 ,  Iteration:   20 ,  Cost Function Value (J) =   7.188652690421828
Epoch:  1 ,  Iteration:   21 ,  Cost Function Value (J) =   33.68629628997208
Epoch:  1 ,  Iteration:   22 ,  Cost Function Value (J) =   34.47959172387546
Epoch:  1 ,  Iteration:   23 ,  Cost Function Value (J) =   46.37370755303649
Epoch:  1 ,  Iteration:   24 ,  Cost Function Value (J) =   0.27040678018359976
Epoch:  1 ,  Iteration:   25 ,  Cost Function Value (J) =   0.4541807659572316
Epoch:  1 ,  Iteration:   26 ,  Cost Function Value (J) =   29.096582047211683
Epoch:  1 ,  Iteration:   27 ,  Cost Function Value (J) =   28.465270445015083
Epoch:  1 ,  Iteration:   28 ,  Cost Function Value (J) =   47.26904011637951
Epoch:  1 ,  Iteration:   29 ,  Cost Function Value (J) =   7.013462200647927
Epoch:  1 ,  Iteration:   30 ,  Cost Function Value (J) =   430.7616384836659
Epoch:  1 ,  Iteration:   31 ,  Cost Function Value (J) =   134.22227674225712
Epoch:  1 ,  Iteration:   32 ,  Cost Function Value (J) =   153.6935712433729
Epoch:  1 ,  Iteration:   33 ,  Cost Function Value (J) =   53.379739939506756
Epoch:  1 ,  Iteration:   34 ,  Cost Function Value (J) =   19.177167954916232
Epoch:  1 ,  Iteration:   35 ,  Cost Function Value (J) =   29.159138580682033
Epoch:  1 ,  Iteration:   36 ,  Cost Function Value (J) =   50.79372293934874
Epoch:  1 ,  Iteration:   37 ,  Cost Function Value (J) =   2.6369114562345226
Epoch:  1 ,  Iteration:   38 ,  Cost Function Value (J) =   18.330089097397202
Epoch:  1 ,  Iteration:   39 ,  Cost Function Value (J) =   1.9130773050612406
Epoch:  1 ,  Iteration:   40 ,  Cost Function Value (J) =   6.7300797366678875
Epoch:  1 ,  Iteration:   41 ,  Cost Function Value (J) =   33.41842568281169
Epoch:  1 ,  Iteration:   42 ,  Cost Function Value (J) =   6.3773265743433845
Epoch:  1 ,  Iteration:   43 ,  Cost Function Value (J) =   29.19879959061208
Epoch:  1 ,  Iteration:   44 ,  Cost Function Value (J) =   13.74934978809667
Epoch:  1 ,  Iteration:   45 ,  Cost Function Value (J) =   0.24544303311362864
Epoch:  1 ,  Iteration:   46 ,  Cost Function Value (J) =   16.62496016149413
Epoch:  1 ,  Iteration:   47 ,  Cost Function Value (J) =   51.88320161838347
Epoch:  1 ,  Iteration:   48 ,  Cost Function Value (J) =   20.066826908745064
Epoch:  1 ,  Iteration:   49 ,  Cost Function Value (J) =   8.595123572740588
Epoch:  1 ,  Iteration:   50 ,  Cost Function Value (J) =   0.6125257127341276
Epoch:  1 ,  Iteration:   51 ,  Cost Function Value (J) =   19.634795323002244
Epoch:  1 ,  Iteration:   52 ,  Cost Function Value (J) =   2.60251009312889
Epoch:  1 ,  Iteration:   53 ,  Cost Function Value (J) =   23.10040507807534
Epoch:  1 ,  Iteration:   54 ,  Cost Function Value (J) =   22.251938676812383
Epoch:  1 ,  Iteration:   55 ,  Cost Function Value (J) =   2.3929682929123675
Epoch:  1 ,  Iteration:   56 ,  Cost Function Value (J) =   250.7737008159786
Epoch:  1 ,  Iteration:   57 ,  Cost Function Value (J) =   141.73882172362974
```

```
Epoch:  1 , Iteration:  58 , Cost Function Value (J) =  59.900091616726506
Epoch:  1 , Iteration:  59 , Cost Function Value (J) =  18.514306940856198
Epoch:  1 , Iteration:  60 , Cost Function Value (J) =  22.539497105820228
Epoch:  1 , Iteration:  61 , Cost Function Value (J) =  13.327246933703416
Epoch:  1 , Iteration:  62 , Cost Function Value (J) =  41.16213359886666
Epoch:  1 , Iteration:  63 , Cost Function Value (J) =  60.01204002090874
Epoch:  1 , Iteration:  64 , Cost Function Value (J) =  15.588891026266234
Epoch:  1 , Iteration:  65 , Cost Function Value (J) =  7.554749046098429
Epoch:  1 , Iteration:  66 , Cost Function Value (J) =  104.71093403119254
Epoch:  1 , Iteration:  67 , Cost Function Value (J) =  29.45144925395889
Epoch:  1 , Iteration:  68 , Cost Function Value (J) =  6.613782144256257
Epoch:  1 , Iteration:  69 , Cost Function Value (J) =  1.303430236642751
Epoch:  1 , Iteration:  70 , Cost Function Value (J) =  38.55502084822023
Epoch:  1 , Iteration:  71 , Cost Function Value (J) =  17.568392114028487
Epoch:  1 , Iteration:  72 , Cost Function Value (J) =  85.88557627593516
Epoch:  1 , Iteration:  73 , Cost Function Value (J) =  79.07983410291105
Epoch:  1 , Iteration:  74 , Cost Function Value (J) =  30.129131107398496
Epoch:  1 , Iteration:  75 , Cost Function Value (J) =  22.140619655985347
Epoch:  1 , Iteration:  76 , Cost Function Value (J) =  65.56701079161103
Epoch:  1 , Iteration:  77 , Cost Function Value (J) =  26.61695598694619
Epoch:  1 , Iteration:  78 , Cost Function Value (J) =  1.3219896676448966
Epoch:  1 , Iteration:  79 , Cost Function Value (J) =  3.608915113322018
Epoch:  1 , Iteration:  80 , Cost Function Value (J) =  8.24400257104736
Epoch:  1 , Iteration:  81 , Cost Function Value (J) =  19.108307412676904
Epoch:  1 , Iteration:  82 , Cost Function Value (J) =  30.95190658860248
Epoch:  1 , Iteration:  83 , Cost Function Value (J) =  78.03795877266998
Epoch:  1 , Iteration:  84 , Cost Function Value (J) =  16.389399369755914
Epoch:  1 , Iteration:  85 , Cost Function Value (J) =  119.02177025824528
Epoch:  1 , Iteration:  86 , Cost Function Value (J) =  39.00245613622231
Epoch:  1 , Iteration:  87 , Cost Function Value (J) =  100.77273098218241
Epoch:  1 , Iteration:  88 , Cost Function Value (J) =  33.776227481061085
Epoch:  1 , Iteration:  89 , Cost Function Value (J) =  38.76618128447394
Epoch:  1 , Iteration:  90 , Cost Function Value (J) =  9.177316946792535
Epoch:  1 , Iteration:  91 , Cost Function Value (J) =  36.421239477416485
Epoch:  1 , Iteration:  92 , Cost Function Value (J) =  131.00507273754314
Epoch:  1 , Iteration:  93 , Cost Function Value (J) =  49.82684673513721
Epoch:  1 , Iteration:  94 , Cost Function Value (J) =  0.7666583592417889
Epoch:  1 , Iteration:  95 , Cost Function Value (J) =  8.656054030014618
Epoch:  1 , Iteration:  96 , Cost Function Value (J) =  103.84706574595064
Epoch:  1 , Iteration:  97 , Cost Function Value (J) =  74.5563043875344
Epoch:  1 , Iteration:  98 , Cost Function Value (J) =  52.09116916119743
Epoch:  1 , Iteration:  99 , Cost Function Value (J) =  147.47387173471142
Epoch:  1 , Iteration:  100 , Cost Function Value (J) =  35.99085795839889
Epoch:  1 , Iteration:  101 , Cost Function Value (J) =  18.194773110508798
Epoch:  1 , Iteration:  102 , Cost Function Value (J) =  84.35986627594745
Epoch:  1 , Iteration:  103 , Cost Function Value (J) =  2.4451135016165257
Epoch:  1 , Iteration:  104 , Cost Function Value (J) =  121.82799894613784
Epoch:  1 , Iteration:  105 , Cost Function Value (J) =  14.068634368450715
Epoch:  1 , Iteration:  106 , Cost Function Value (J) =  3.74773218648126
Epoch:  1 , Iteration:  107 , Cost Function Value (J) =  11.651430913006026
Epoch:  1 , Iteration:  108 , Cost Function Value (J) =  40.35017023192852
Epoch:  1 , Iteration:  109 , Cost Function Value (J) =  23.545290393271415
Epoch:  1 , Iteration:  110 , Cost Function Value (J) =  6.542627496377363
Epoch:  1 , Iteration:  111 , Cost Function Value (J) =  152.4504190127119
Epoch:  1 , Iteration:  112 , Cost Function Value (J) =  173.26648675390027
Epoch:  1 , Iteration:  113 , Cost Function Value (J) =  28.16862118213855
Epoch:  1 , Iteration:  114 , Cost Function Value (J) =  26.99843501880378
Epoch:  1 , Iteration:  115 , Cost Function Value (J) =  21.759616047160954
Epoch:  1 , Iteration:  116 , Cost Function Value (J) =  26.000572146202323
Epoch:  1 , Iteration:  117 , Cost Function Value (J) =  37.830837410501395
Epoch:  1 , Iteration:  118 , Cost Function Value (J) =  5.019996583169169
Epoch:  1 , Iteration:  119 , Cost Function Value (J) =  39.0064041106177
Epoch:  1 , Iteration:  120 , Cost Function Value (J) =  0.1833135554575334
Epoch:  1 , Iteration:  121 , Cost Function Value (J) =  70.32474259331886
Epoch:  1 , Iteration:  122 , Cost Function Value (J) =  21.642414000371886
Epoch:  1 , Iteration:  123 , Cost Function Value (J) =  6.620503792432165
```

```
Epoch:  1 , Iteration:  124 , Cost Function Value (J) =  10.18195837814161
Epoch:  1 , Iteration:  125 , Cost Function Value (J) =  204.03642483123667
Epoch:  1 , Iteration:  126 , Cost Function Value (J) =  67.44796791627392
Epoch:  1 , Iteration:  127 , Cost Function Value (J) =  10.020495460071112
Epoch:  1 , Iteration:  128 , Cost Function Value (J) =  6.868961627820962
Epoch:  1 , Iteration:  129 , Cost Function Value (J) =  0.3923781462863815
Epoch:  1 , Iteration:  130 , Cost Function Value (J) =  18.97062890478872
Epoch:  1 , Iteration:  131 , Cost Function Value (J) =  14.1774106632752
Epoch:  1 , Iteration:  132 , Cost Function Value (J) =  14.783448847114192
Epoch:  1 , Iteration:  133 , Cost Function Value (J) =  39.55208076301268
Epoch:  1 , Iteration:  134 , Cost Function Value (J) =  1.9572733921847854
Epoch:  1 , Iteration:  135 , Cost Function Value (J) =  58.35670443005044
Epoch:  1 , Iteration:  136 , Cost Function Value (J) =  13.849216530480062
Epoch:  1 , Iteration:  137 , Cost Function Value (J) =  119.64158498800774
Epoch:  1 , Iteration:  138 , Cost Function Value (J) =  68.213267024537
Epoch:  1 , Iteration:  139 , Cost Function Value (J) =  107.41962641503665
Epoch:  1 , Iteration:  140 , Cost Function Value (J) =  16.561358093536434
Epoch:  1 , Iteration:  141 , Cost Function Value (J) =  22.384699117333295
Epoch:  1 , Iteration:  142 , Cost Function Value (J) =  28.335325452054818
Epoch:  1 , Iteration:  143 , Cost Function Value (J) =  2.9590495841899123
Epoch:  1 , Iteration:  144 , Cost Function Value (J) =  11.523406951349138
Epoch:  1 , Iteration:  145 , Cost Function Value (J) =  59.623877982849244
Epoch:  1 , Iteration:  146 , Cost Function Value (J) =  5.007780022540851
Epoch:  1 , Iteration:  147 , Cost Function Value (J) =  48.167803276752025
Epoch:  1 , Iteration:  148 , Cost Function Value (J) =  7.482572058664779
Epoch:  1 , Iteration:  149 , Cost Function Value (J) =  22.397241922919694
Epoch:  1 , Iteration:  150 , Cost Function Value (J) =  16.568450752195655
Epoch:  1 , Iteration:  151 , Cost Function Value (J) =  61.14552370027894
Epoch:  1 , Iteration:  152 , Cost Function Value (J) =  38.28803309392456
Epoch:  1 , Iteration:  153 , Cost Function Value (J) =  31.76223766394973
Epoch:  1 , Iteration:  154 , Cost Function Value (J) =  0.003159508073781202
Epoch:  1 , Iteration:  155 , Cost Function Value (J) =  39.83320368665323
Epoch:  1 , Iteration:  156 , Cost Function Value (J) =  5.375970578278214
Epoch:  1 , Iteration:  157 , Cost Function Value (J) =  47.86853019945914
Epoch:  1 , Iteration:  158 , Cost Function Value (J) =  6.529381438405906
Epoch:  1 , Iteration:  159 , Cost Function Value (J) =  0.02178993699821898
Epoch:  1 , Iteration:  160 , Cost Function Value (J) =  26.640926912502486
Epoch:  2 , Iteration:  1 , Cost Function Value (J) =  7.921451577013778
Epoch:  2 , Iteration:  2 , Cost Function Value (J) =  11.899633937870304
Epoch:  2 , Iteration:  3 , Cost Function Value (J) =  29.59503437075729
Epoch:  2 , Iteration:  4 , Cost Function Value (J) =  15.727842360512115
Epoch:  2 , Iteration:  5 , Cost Function Value (J) =  208.90887342619564
Epoch:  2 , Iteration:  6 , Cost Function Value (J) =  242.78103810137293
Epoch:  2 , Iteration:  7 , Cost Function Value (J) =  6.756654467243891
Epoch:  2 , Iteration:  8 , Cost Function Value (J) =  7.637446623703977
Epoch:  2 , Iteration:  9 , Cost Function Value (J) =  48.04668118583708
Epoch:  2 , Iteration:  10 , Cost Function Value (J) =  6.129268020403348
Epoch:  2 , Iteration:  11 , Cost Function Value (J) =  7.382947311644045
Epoch:  2 , Iteration:  12 , Cost Function Value (J) =  12.689668353714849
Epoch:  2 , Iteration:  13 , Cost Function Value (J) =  34.61131970116623
Epoch:  2 , Iteration:  14 , Cost Function Value (J) =  56.317571970327094
Epoch:  2 , Iteration:  15 , Cost Function Value (J) =  19.778759952009842
Epoch:  2 , Iteration:  16 , Cost Function Value (J) =  30.486948921584716
Epoch:  2 , Iteration:  17 , Cost Function Value (J) =  6.1779158606995255
Epoch:  2 , Iteration:  18 , Cost Function Value (J) =  33.555372186057355
Epoch:  2 , Iteration:  19 , Cost Function Value (J) =  18.26658360369295
Epoch:  2 , Iteration:  20 , Cost Function Value (J) =  7.162160103917782
Epoch:  2 , Iteration:  21 , Cost Function Value (J) =  33.626165415679914
Epoch:  2 , Iteration:  22 , Cost Function Value (J) =  34.41485058040177
Epoch:  2 , Iteration:  23 , Cost Function Value (J) =  46.30517991072644
Epoch:  2 , Iteration:  24 , Cost Function Value (J) =  0.2692751631940756
Epoch:  2 , Iteration:  25 , Cost Function Value (J) =  0.44955848880957294
Epoch:  2 , Iteration:  26 , Cost Function Value (J) =  29.107237631572705
Epoch:  2 , Iteration:  27 , Cost Function Value (J) =  28.43087842770534
Epoch:  2 , Iteration:  28 , Cost Function Value (J) =  47.22946963946475
Epoch:  2 , Iteration:  29 , Cost Function Value (J) =  6.993468981542481
```

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Epoch:  2 , Iteration:  30 , Cost Function Value (J) =  430.41018471926117
Epoch:  2 , Iteration:  31 , Cost Function Value (J) =  134.08872884641892
Epoch:  2 , Iteration:  32 , Cost Function Value (J) =  153.63387064532324
Epoch:  2 , Iteration:  33 , Cost Function Value (J) =  53.37615002725113
Epoch:  2 , Iteration:  34 , Cost Function Value (J) =  19.12445671094725
Epoch:  2 , Iteration:  35 , Cost Function Value (J) =  29.146907093058605
Epoch:  2 , Iteration:  36 , Cost Function Value (J) =  50.761075472990846
Epoch:  2 , Iteration:  37 , Cost Function Value (J) =  2.634417975706365
Epoch:  2 , Iteration:  38 , Cost Function Value (J) =  18.33937910236856
Epoch:  2 , Iteration:  39 , Cost Function Value (J) =  1.9135848483741558
Epoch:  2 , Iteration:  40 , Cost Function Value (J) =  6.723505967390632
Epoch:  2 , Iteration:  41 , Cost Function Value (J) =  33.422563411341926
Epoch:  2 , Iteration:  42 , Cost Function Value (J) =  6.366203947031965
Epoch:  2 , Iteration:  43 , Cost Function Value (J) =  29.160468709048878
Epoch:  2 , Iteration:  44 , Cost Function Value (J) =  13.749306858612615
Epoch:  2 , Iteration:  45 , Cost Function Value (J) =  0.2433845770836082
Epoch:  2 , Iteration:  46 , Cost Function Value (J) =  16.604561205471157
Epoch:  2 , Iteration:  47 , Cost Function Value (J) =  51.86264344308287
Epoch:  2 , Iteration:  48 , Cost Function Value (J) =  20.049806801022743
Epoch:  2 , Iteration:  49 , Cost Function Value (J) =  8.583580007711985
Epoch:  2 , Iteration:  50 , Cost Function Value (J) =  0.6133345985700227
Epoch:  2 , Iteration:  51 , Cost Function Value (J) =  19.631725551642003
Epoch:  2 , Iteration:  52 , Cost Function Value (J) =  2.604497737952468
Epoch:  2 , Iteration:  53 , Cost Function Value (J) =  23.04334569944982
Epoch:  2 , Iteration:  54 , Cost Function Value (J) =  22.273765650027716
Epoch:  2 , Iteration:  55 , Cost Function Value (J) =  2.4013537308253556
Epoch:  2 , Iteration:  56 , Cost Function Value (J) =  250.61377357495206
Epoch:  2 , Iteration:  57 , Cost Function Value (J) =  141.61604843309996
Epoch:  2 , Iteration:  58 , Cost Function Value (J) =  59.868259920745615
Epoch:  2 , Iteration:  59 , Cost Function Value (J) =  18.5181043545147
Epoch:  2 , Iteration:  60 , Cost Function Value (J) =  22.534267377965186
Epoch:  2 , Iteration:  61 , Cost Function Value (J) =  13.315935697005376
Epoch:  2 , Iteration:  62 , Cost Function Value (J) =  41.15144619922882
Epoch:  2 , Iteration:  63 , Cost Function Value (J) =  59.92827810180004
Epoch:  2 , Iteration:  64 , Cost Function Value (J) =  15.55860269423462
Epoch:  2 , Iteration:  65 , Cost Function Value (J) =  7.549330582937616
Epoch:  2 , Iteration:  66 , Cost Function Value (J) =  104.63472847831655
Epoch:  2 , Iteration:  67 , Cost Function Value (J) =  29.41284241126674
Epoch:  2 , Iteration:  68 , Cost Function Value (J) =  6.6305545276919275
Epoch:  2 , Iteration:  69 , Cost Function Value (J) =  1.2953600628077655
Epoch:  2 , Iteration:  70 , Cost Function Value (J) =  38.48262155836608
Epoch:  2 , Iteration:  71 , Cost Function Value (J) =  17.562727515315267
Epoch:  2 , Iteration:  72 , Cost Function Value (J) =  85.85249312084295
Epoch:  2 , Iteration:  73 , Cost Function Value (J) =  79.00698780858447
Epoch:  2 , Iteration:  74 , Cost Function Value (J) =  30.108868887700172
Epoch:  2 , Iteration:  75 , Cost Function Value (J) =  22.11482910316536
Epoch:  2 , Iteration:  76 , Cost Function Value (J) =  65.48864608167527
Epoch:  2 , Iteration:  77 , Cost Function Value (J) =  26.564162757316826
Epoch:  2 , Iteration:  78 , Cost Function Value (J) =  1.3187457002277752
Epoch:  2 , Iteration:  79 , Cost Function Value (J) =  3.598785468320992
Epoch:  2 , Iteration:  80 , Cost Function Value (J) =  8.220857676705638
Epoch:  2 , Iteration:  81 , Cost Function Value (J) =  19.068579442904984
Epoch:  2 , Iteration:  82 , Cost Function Value (J) =  30.991229787405796
Epoch:  2 , Iteration:  83 , Cost Function Value (J) =  78.07694762200062
Epoch:  2 , Iteration:  84 , Cost Function Value (J) =  16.387997166591802
Epoch:  2 , Iteration:  85 , Cost Function Value (J) =  118.97688636402017
Epoch:  2 , Iteration:  86 , Cost Function Value (J) =  38.928492992595004
Epoch:  2 , Iteration:  87 , Cost Function Value (J) =  100.66135563395582
Epoch:  2 , Iteration:  88 , Cost Function Value (J) =  33.75703531242131
Epoch:  2 , Iteration:  89 , Cost Function Value (J) =  38.73860112997807
Epoch:  2 , Iteration:  90 , Cost Function Value (J) =  9.154578173321683
Epoch:  2 , Iteration:  91 , Cost Function Value (J) =  36.34918359498955
Epoch:  2 , Iteration:  92 , Cost Function Value (J) =  130.93229761465992
Epoch:  2 , Iteration:  93 , Cost Function Value (J) =  49.74896311790604
Epoch:  2 , Iteration:  94 , Cost Function Value (J) =  0.7635391682879473
Epoch:  2 , Iteration:  95 , Cost Function Value (J) =  8.631347304425407
```

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Epoch:  2 , Iteration:  96 , Cost Function Value (J) =  103.90922789311567
Epoch:  2 , Iteration:  97 , Cost Function Value (J) =  74.48419506132112
Epoch:  2 , Iteration:  98 , Cost Function Value (J) =  52.00991107010202
Epoch:  2 , Iteration:  99 , Cost Function Value (J) =  147.53392417847564
Epoch:  2 , Iteration:  100 , Cost Function Value (J) =  35.92381987499596
Epoch:  2 , Iteration:  101 , Cost Function Value (J) =  18.198670612934787
Epoch:  2 , Iteration:  102 , Cost Function Value (J) =  84.34509186779727
Epoch:  2 , Iteration:  103 , Cost Function Value (J) =  2.4256754590596983
Epoch:  2 , Iteration:  104 , Cost Function Value (J) =  121.76662615846445
Epoch:  2 , Iteration:  105 , Cost Function Value (J) =  14.065796027669327
Epoch:  2 , Iteration:  106 , Cost Function Value (J) =  3.7461162378264543
Epoch:  2 , Iteration:  107 , Cost Function Value (J) =  11.66043631700159
Epoch:  2 , Iteration:  108 , Cost Function Value (J) =  40.273822950511395
Epoch:  2 , Iteration:  109 , Cost Function Value (J) =  23.56357720610005
Epoch:  2 , Iteration:  110 , Cost Function Value (J) =  6.555801554394425
Epoch:  2 , Iteration:  111 , Cost Function Value (J) =  152.46212541011215
Epoch:  2 , Iteration:  112 , Cost Function Value (J) =  173.2566854250768
Epoch:  2 , Iteration:  113 , Cost Function Value (J) =  28.12499279659055
Epoch:  2 , Iteration:  114 , Cost Function Value (J) =  26.947831651066995
Epoch:  2 , Iteration:  115 , Cost Function Value (J) =  21.758649371534442
Epoch:  2 , Iteration:  116 , Cost Function Value (J) =  25.964728072567777
Epoch:  2 , Iteration:  117 , Cost Function Value (J) =  37.783124616883825
Epoch:  2 , Iteration:  118 , Cost Function Value (J) =  5.017164855790603
Epoch:  2 , Iteration:  119 , Cost Function Value (J) =  38.95686069000036
Epoch:  2 , Iteration:  120 , Cost Function Value (J) =  0.18386774507035422
Epoch:  2 , Iteration:  121 , Cost Function Value (J) =  70.24527509343255
Epoch:  2 , Iteration:  122 , Cost Function Value (J) =  21.668147534679214
Epoch:  2 , Iteration:  123 , Cost Function Value (J) =  6.594322305077164
Epoch:  2 , Iteration:  124 , Cost Function Value (J) =  10.155667700923386
Epoch:  2 , Iteration:  125 , Cost Function Value (J) =  204.01440336900367
Epoch:  2 , Iteration:  126 , Cost Function Value (J) =  67.41007410098331
Epoch:  2 , Iteration:  127 , Cost Function Value (J) =  10.028813002376578
Epoch:  2 , Iteration:  128 , Cost Function Value (J) =  6.847702402403628
Epoch:  2 , Iteration:  129 , Cost Function Value (J) =  0.388737168478274
Epoch:  2 , Iteration:  130 , Cost Function Value (J) =  18.920906693066428
Epoch:  2 , Iteration:  131 , Cost Function Value (J) =  14.196903624375125
Epoch:  2 , Iteration:  132 , Cost Function Value (J) =  14.742009869114936
Epoch:  2 , Iteration:  133 , Cost Function Value (J) =  39.54413992164232
Epoch:  2 , Iteration:  134 , Cost Function Value (J) =  1.9558840782873563
Epoch:  2 , Iteration:  135 , Cost Function Value (J) =  58.30329448587047
Epoch:  2 , Iteration:  136 , Cost Function Value (J) =  13.819369855492793
Epoch:  2 , Iteration:  137 , Cost Function Value (J) =  119.56373503292565
Epoch:  2 , Iteration:  138 , Cost Function Value (J) =  68.12759442572133
Epoch:  2 , Iteration:  139 , Cost Function Value (J) =  107.38823745530539
Epoch:  2 , Iteration:  140 , Cost Function Value (J) =  16.560813096413245
Epoch:  2 , Iteration:  141 , Cost Function Value (J) =  22.33159787909588
Epoch:  2 , Iteration:  142 , Cost Function Value (J) =  28.285884792431506
Epoch:  2 , Iteration:  143 , Cost Function Value (J) =  2.947150479876715
Epoch:  2 , Iteration:  144 , Cost Function Value (J) =  11.538786506768497
Epoch:  2 , Iteration:  145 , Cost Function Value (J) =  59.53568144962864
Epoch:  2 , Iteration:  146 , Cost Function Value (J) =  5.011649537104069
Epoch:  2 , Iteration:  147 , Cost Function Value (J) =  48.08799118078751
Epoch:  2 , Iteration:  148 , Cost Function Value (J) =  7.4947546306403705
Epoch:  2 , Iteration:  149 , Cost Function Value (J) =  22.394668701146628
Epoch:  2 , Iteration:  150 , Cost Function Value (J) =  16.534038863569492
Epoch:  2 , Iteration:  151 , Cost Function Value (J) =  61.10195398260555
Epoch:  2 , Iteration:  152 , Cost Function Value (J) =  38.21351971247233
Epoch:  2 , Iteration:  153 , Cost Function Value (J) =  31.753564395899627
Epoch:  2 , Iteration:  154 , Cost Function Value (J) =  0.003362116383596389
Epoch:  2 , Iteration:  155 , Cost Function Value (J) =  39.834372911689705
Epoch:  2 , Iteration:  156 , Cost Function Value (J) =  5.3556769624088085
Epoch:  2 , Iteration:  157 , Cost Function Value (J) =  47.7927552450124
Epoch:  2 , Iteration:  158 , Cost Function Value (J) =  6.540878004881757
Epoch:  2 , Iteration:  159 , Cost Function Value (J) =  0.022023972666488985
Epoch:  2 , Iteration:  160 , Cost Function Value (J) =  26.59545136523986
```

```
# Simple Linear Regression - SGD - Prediction

print('B0 (intercept) = ',b0)
print('B1 (slope) = ',b1)

y_pred_sgd = predict(X_test,b0,b1)

results['SGD'] = y_pred_sgd
results
```

```
B0 (intercept) =  0.012963678644417758
B1 (slope) =  0.08917508066653065
```

	Actual	Analytical	SGD
179	12.6	14.905518	14.780357
155	3.2	7.420354	0.378582
23	15.5	17.811523	20.371635
159	12.9	13.334329	11.757322
96	11.7	16.388647	17.633960
198	25.5	20.374554	25.303017
42	20.7	20.838032	26.194767
110	13.4	17.695654	20.148697
128	24.7	17.440741	19.658234
97	15.5	15.800030	16.501436
95	16.9	14.798918	14.575254
106	7.2	8.389023	2.242341
65	9.3	10.428324	6.166044
33	17.4	19.540294	23.697865
102	14.8	20.216972	24.999821
89	16.7	12.319313	9.804388
132	5.7	7.619650	0.762034
79	11.0	12.606669	10.357273
104	20.7	18.270366	21.254468
70	18.3	16.458168	17.767722
173	11.7	15.035292	15.030047
129	9.7	9.992655	5.327798
30	21.4	20.805588	26.132345
7	13.2	12.801330	10.731808
168	17.1	17.213637	19.221276
124	19.7	17.867140	20.478645
157	10.1	14.173224	13.371391
165	11.9	18.098879	20.924520
101	23.8	20.967806	26.444458

	Actual	Analytical	SGD
78	5.3	7.480607	0.494509
87	16.0	12.361026	9.884645
141	19.2	16.207890	17.286177
105	19.2	13.621685	12.310207
10	8.6	10.293916	5.907437
64	18.0	13.306520	11.703817
13	9.7	11.749236	8.707534
90	11.2	13.454833	11.989177
15	22.4	16.286682	17.437774
195	7.6	9.000813	3.419452
94	11.5	12.208078	9.590367

In [44]:
```python
# Simple Linear Regression - SGD - Prediction

X_ip = float(input('Enter value of marketing budget : '))
print('Predicted Sales value is : ',predict(X_ip,b0,b1))
```

Enter value of marketing budget : 40.5
Predicted Sales value is :   3.624554445638909

In [45]:
```python
# Simple Linear Regression - SGD - Regression Line

plt.figure(figsize=(5, 4))
ax = plt.axes()
ax.scatter(X,y)
ax.plot(X,predict(X,b0,b1),color='red')
plt.title('Regression Line - SGD Method')
ax.set_xlabel('TV Marketing Budget')
ax.set_ylabel('Sales')
plt.show()
```


Interpretation of Results : Thus the relationship between marketing and sales is positive and for every 1 unit of increase in marketing budget, the sales increases by b1 = 0.0892