Q3.2 Quadratic Least Square Fitting

Importing Libraries

In [1]:

```python
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from prettytable import PrettyTable as ptbl
```

Importing database

In [2]:

```python
data = pd.read_csv('Quadratic_curve_fitting_dataset.csv')
```

Visualizing database

In [3]:

```python
data.head()
```

Out[3]:

	x	y
0	2	5
1	5	140
2	8	455
3	11	950
4	14	1625

Extracing Dependent and independent variables from database in X and y variables respectively

In [4]:

```python
X = data.iloc[:,0].values
y = data.iloc[:,1].values
```

Quadratic Least square fitting function

y = c1*x^2 + c2*x + c3

In [5]:

```python
def QuadraticFitting(x,y):

    x_four_sum = sum(x**4)
    x_three_sum = sum(x**3)
    x_sq_sum = sum(x**2)
    x_sum = sum(x)
    n = len(x)

    y_xsq_sum = sum(y*(x**2))
    yx_sum = sum(x*y)
    y_sum = sum(y)

    A = np.array([
        [x_four_sum,  x_three_sum,  x_sq_sum],
        [x_three_sum, x_sq_sum,     x_sq_sum],
        [x_sq_sum,    x_sum,        n],
        ])

    b = np.array([
        [y_xsq_sum],
        [yx_sum],
        [y_sum]
        ])

    invA = np.linalg.inv(A)
    M = np.matmul(invA,b)

    return M
```

Calling Quadratic least square fitting function on given database

In [6]:

```python
c1, c2, c3 = QuadraticFitting(X,y)
```

Visualizing coefficients and constants

In [7]:

```python
print(c1,c2,c3)
```

```
[9.99671939] [-24.47209128] [-0.008132]
```

Calculating Approximate Values

In [8]:

```python
y_pred = c1*(X**2) + c2*X + c3
```

Table of actual values and predicted values

In [9]:

```python
table = ptbl(['X','y','y-predicted'])
for i in range(len(X)):
    table.add_row([X[i],y[i],y_pred[i]])
print(table)
```

```
+-----+--------+--------------------+
|  X  |   y    |    y-predicted     |
+-----+--------+--------------------+
|  2  |   5    | -8.965437008384214 |
|  5  |  140   | 127.54939634349978 |
|  8  |  455   | 444.00517872570873 |
|  11 |  950   | 940.4019101382426  |
|  14 |  1625  | 1616.7395905811015 |
|  17 |  2480  | 2473.0182200542854 |
|  20 |  3515  | 3509.2377985577946 |
|  23 |  4730  | 4725.398326091627 5|
|  26 |  6125  | 6121.499802655787  |
|  29 |  7700  | 7697.5422282502695 |
|  32 |  9455  |  9453.52560287508  |
|  35 | 11390  | 11389.449926530213 |
|  38 | 13505  | 13505.31519921567  |
|  41 | 15800  | 15801.121420931455 |
|  44 | 18275  | 18276.868591677565 |
|  47 | 20930  |  20932.556711454   |
|  50 | 23765  | 23768.18578026076  |
|  53 | 26780  | 26783.75579809784  |
|  56 | 29975  | 29979.26676496525  |
|  59 | 33350  | 33354.718680862985 |
|  62 | 36905  | 36910.11154579104  |
|  65 | 40640  | 40645.44535974943  |
|  68 | 44555  | 44560.72012273813  |
|  71 | 48650  | 48655.93583475717  |
|  74 | 52925  | 52931.09249580652  |
|  77 | 57380  | 57386.190105886206 |
|  80 | 62015  | 62021.22866499622  |
|  83 | 66830  | 66836.20817313655  |
|  86 | 71825  | 71831.12863030721  |
|  89 | 77000  | 77005.99003650818  |
|  92 | 82355  |  82360.7923917395  |
|  95 | 87890  | 87895.53569600113  |
|  98 | 93605  |  93610.2199492931  |
| 101 | 99500  | 99504.8451516153 7 |
| 104 | 105575 | 105579.41130296799 |
| 107 | 111830 | 111833.91840335092 |
| 110 | 118265 | 118268.3664527641 7|
| 113 | 124880 | 124882.75545120776 |
| 116 | 131675 | 131677.08539868164 |
| 119 | 138650 | 138651.3562951859  |
| 122 | 145805 | 145805.5681407204 5|
| 125 | 153140 | 153139.72093528532 |
| 128 | 160655 | 160653.81467888053 |
| 131 | 168350 | 168347.84937150608 |
| 134 | 176225 | 176221.82501316193 |
| 137 | 184280 | 184275.7416038481 2|
| 140 | 192515 | 192509.5991435646  |
| 143 | 200930 | 200923.39763231145 |
| 146 | 209525 | 209517.1370700886  |
| 149 | 218300 | 218290.8174568961  |
+-----+--------+--------------------+
```

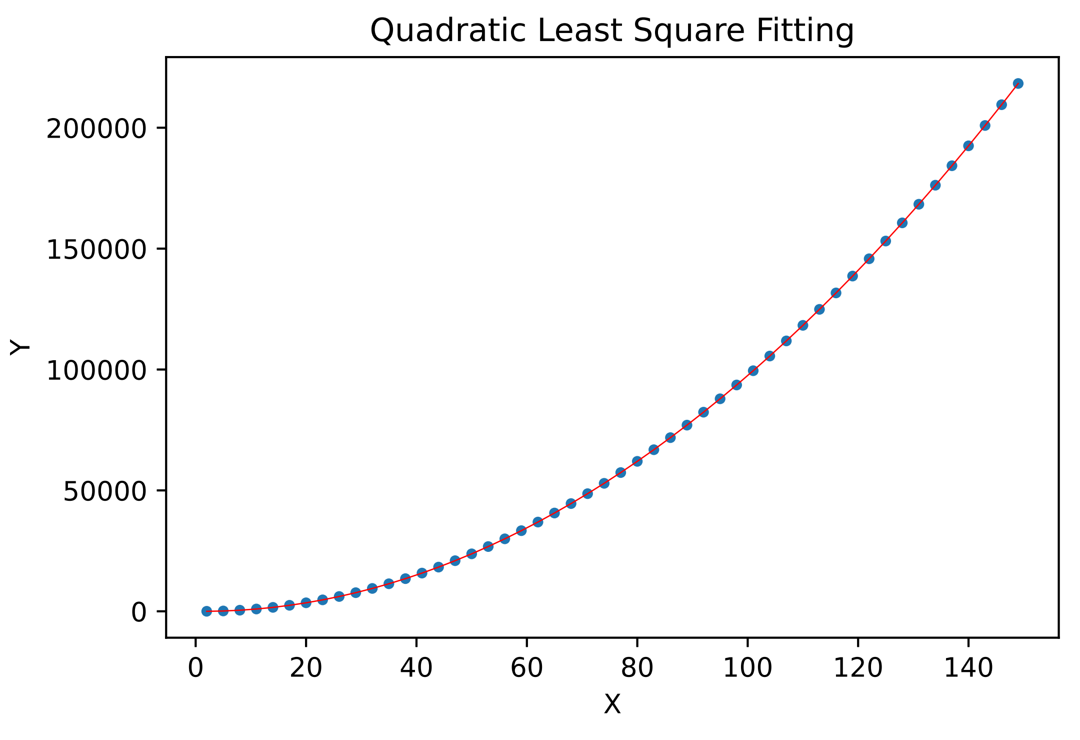
Visualizing Best Fit Curve

Note: The database used here was generated by me using Microsoft EXCEL

that's why the actual points are perfectly overlapping with approximate line

In [10]:

```python
plt.scatter(X,y, marker = '.')
plt.plot(X,y_pred,color = 'red',linewidth = 0.5)
plt.title('Quadratic Least Square Fitting')
plt.xlabel('X')
plt.ylabel('Y')
plt.show()
```



Evaluating Error in reconstruction

In [11]:

```python
max_error = max(abs(y-y_pred)/y)
print(max_error)
```

```
2.7930874016768428
```

here the first approximate value is way off from the actual value

that's why the error is too large

In [12]:

```python
for i in range(5):
    print(f"y[{i}] = {y[i]}\ty_predict[{i}] = {y_pred[i]}")
```

```
y[0] = 5        y_predict[0] = -8.965437008384214
y[1] = 140      y_predict[1] = 127.54939634349978
y[2] = 455      y_predict[2] = 444.00517872570873
y[3] = 950      y_predict[3] = 940.4019101382426
y[4] = 1625     y_predict[4] = 1616.7395905811015
```

Also it can be seen that as we go on calculating the approximate values the error goes on decreasing