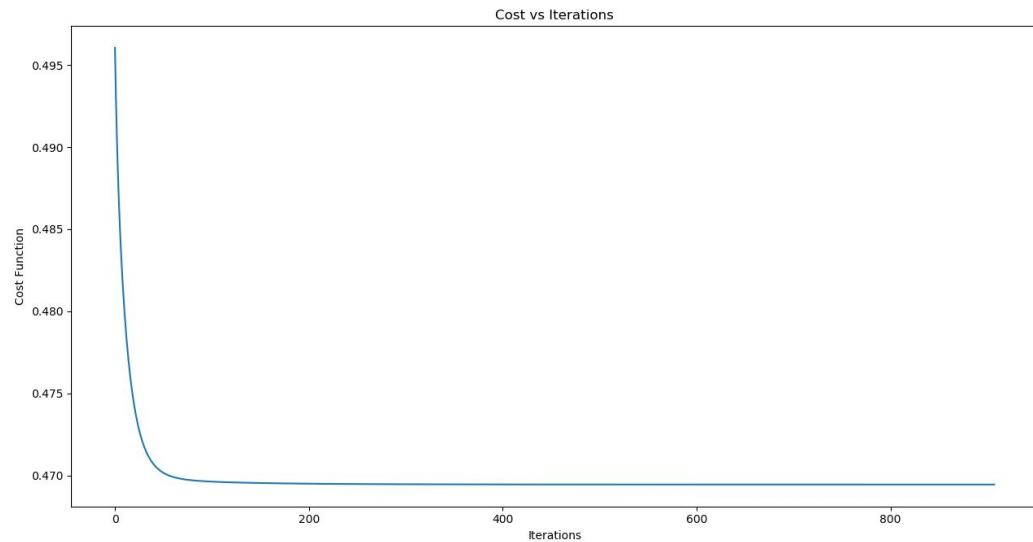**ASSIGNMENT -2**
Rohan Panda - 2017A3PS0487H
Rayyan Shaikh - 2017A3PS0351H

A)   **2 Degree:**

Graph:

The stopping criteria was reached after 907 iterations. Hence the graph is plotted for the same no. of iterations.
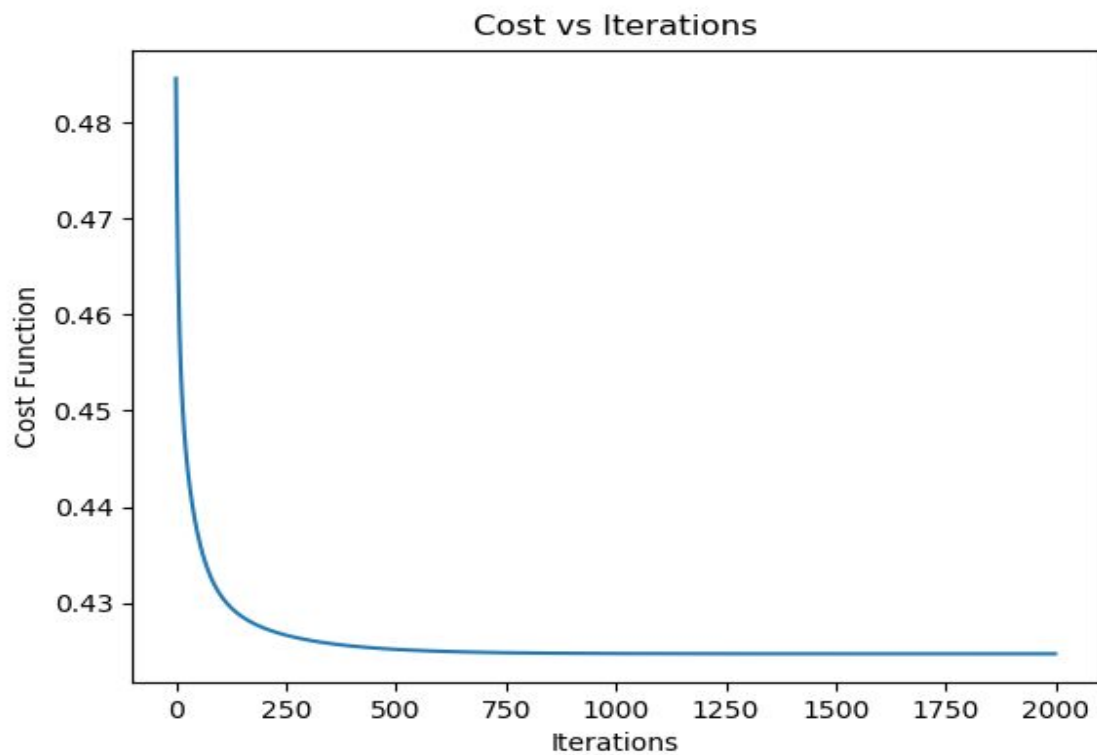
Results:

R-Square: 0.061079

SE: 0.469454

RMSE: 0.685167

3 Degree:

Graph:

Results:

```
W values  [[ 1.60246743e-04]
 [-6.12166071e-02]
 [ 1.88395591e-01]
 [-1.33652499e-01]
 [ 5.07857961e-01]
 [ 2.18006173e-02]
 [-3.11997514e-01]
 [-2.04630046e-01]
 [ 5.73774154e-01]
 [-3.14481416e-01]]
rsquare: [0.15046014]
SE 0.42471361766220744
RMSE 0.6517005582798034
```
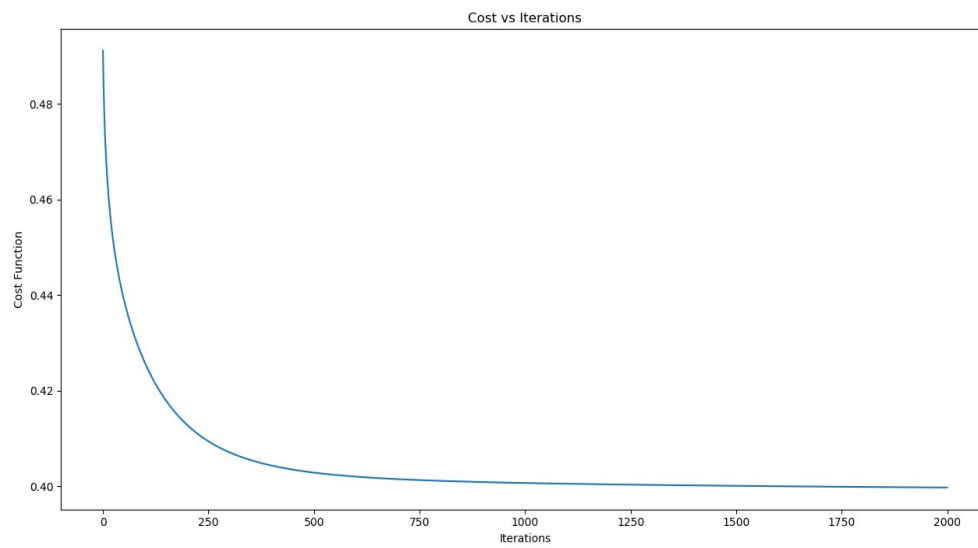
R-Square: 0.150460

SE: 0.424713

RMSE: 0.651700

4 Degree:

Graph:

Results:

```
W values   [[-0.14132227]
 [-0.23511445]
 [ 0.52676916]
 [-0.06999772]
 [-0.10186475]
 [ 0.4456421 ]
 [ 0.19314985]
 [-0.07454132]
 [ 0.02541655]
 [-0.17626123]
 [ 0.40583729]
 [-0.33399771]
 [-0.27428178]
 [ 0.2118896 ]
 [-0.04285563]]
rsquare: [0.19679361]
SE 0.3997137893751906̲4
RMSE 0.63222922217751̲9
```
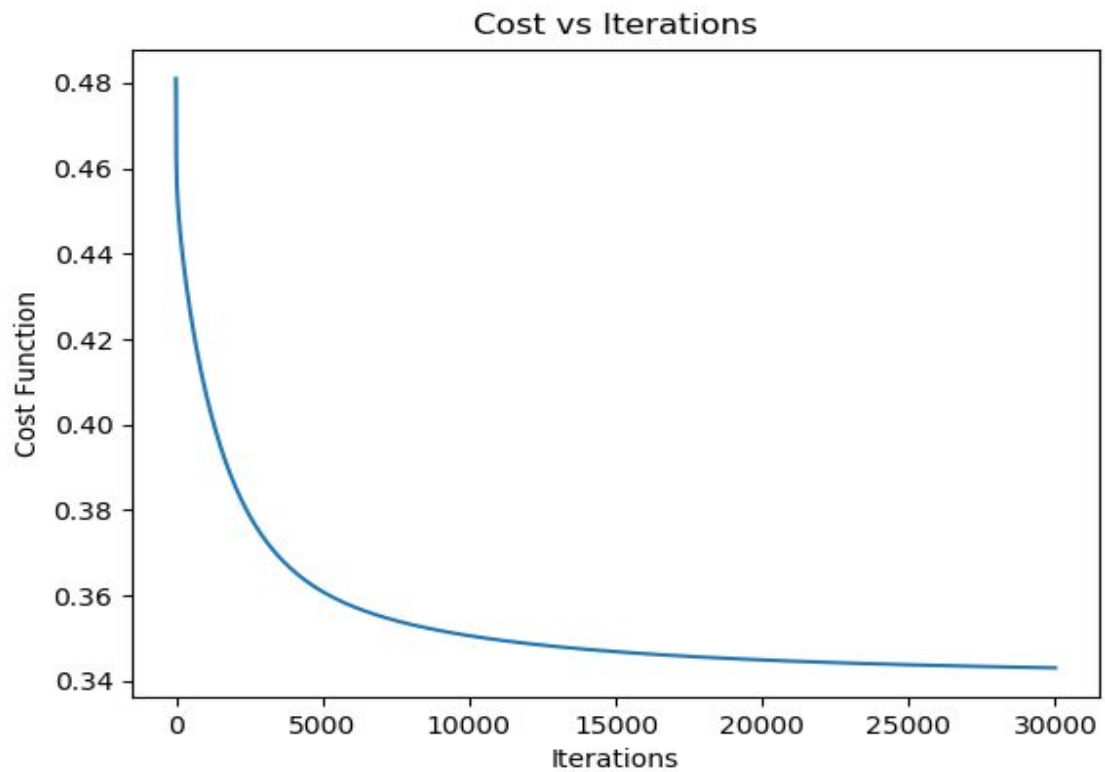
R-Square: 0.196793

SE: 0.399713

RMSE: 0.632229

5 Degree:

Graph:

Cost vs Iterations

Results:

```
W values   [[-0.20458241]
 [ 0.25596208]
 [ 0.90240025]
 [-1.15267616]
 [-0.32918504]
 [ 0.30089772]
 [ 0.98627821]
 [ 0.79392813]
 [ 0.27027956]
 [ 0.128419  ]
 [ 0.10825879]
 [-0.47219891]
 [ 1.04697156]
 [-0.73495101]
 [-0.41669151]
 [-1.07036572]
 [ 0.21109086]
 [ 0.01022898]
 [ 0.01311722]
 [-0.09223539]
 [ 0.14321457]]
rsquare: [0.29860797]
SE 0.3431022416803263
RMSE 0.585749299342585
```
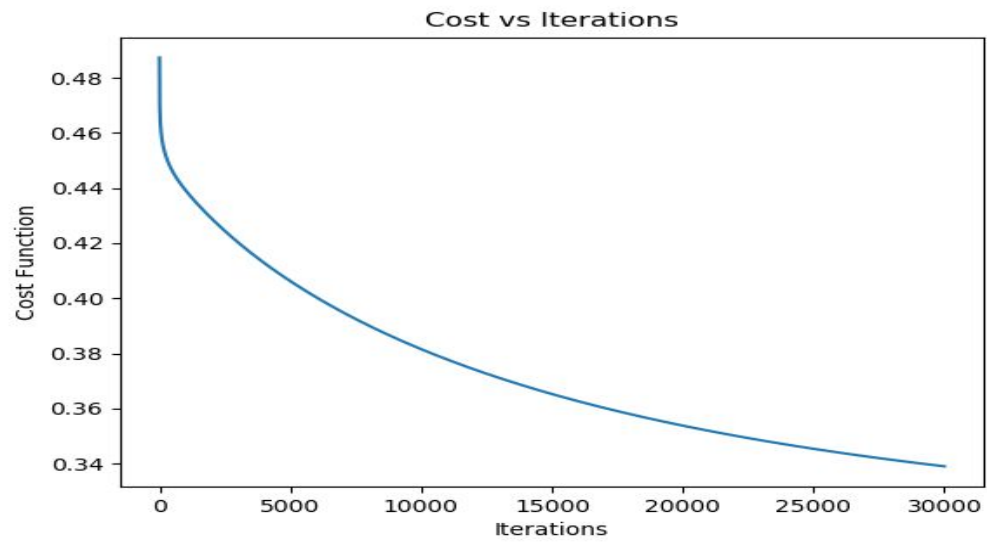
R-Square: 0.298607

SE: 0.343102

RMSE: 0.585749

6 Degree:

Graph:

Cost vs Iterations

Results:

```
W values  [[-0.19409434]
 [-0.0350755 ]
 [ 0.96456758]
 [-0.41476322]
 [-0.40015692]
 [ 0.07772605]
 [ 0.02797854]
 [ 0.61998344]
 [ 0.62131491]
 [ 0.3743044 ]
 [-0.36151219]
 [ 0.03667103]
 [ 0.10096804]
 [-0.2404992 ]
 [ 0.62064388]
 [-0.36275995]
 [-0.08597876]
 [ 0.04880443]
 [-0.59779743]
 [ 0.23958001]
 [-0.48701996]
 [ 0.02395293]
 [-0.07014734]
 [ 0.18875996]
 [-0.2132648 ]
 [ 0.03411703]
 [ 0.09206986]
 [-0.00534162]]
rsquare: [0.21700973]
SE 0.339086398708529
RMSE 0.5822702464241608
```

R-Square: 0.217009

SE: 0.339038

RMSE: 0.582270

B)   Comparison:

Degree	R-Square	RMSE	SE
2	0.061079	0.685167	0.469454
3	0.150460	0.651700	0.424713
4	0.196793	0.632229	0.399713
5	0.298607	0.343102	0.585749

6	0.217009	0.339038	0.582270

The following values are evaluated for the complete dataset.

Generally, regularization limits overfitting by restricting the weights from exploding or holding onto the irregularities found in the data.

As we see that the error values are close by and do not drastically decrease as we increase the degree of the polynomial we can safely say that **none of the models try to overfit** on the data and pick up the irregularities. Also we notice that on increasing the degree of the polynomial the RMSE keeps decreasing and the R2 value keeps increasing thereby showing that **higher degree polynomials can better describe the data given.**

C)   <u>6th Degree with Regularization:</u>

Regularization	Training MSE	Testing MSE
L1(λ=0.01)	0.64	0.60
L2(λ=0.01)	0.64	0.61

We notice that the 6th degree polynomial does not overfit on the data and hence we take a lower value of regularization factor (lambda). The graph below shows the trend of cost vs parameter depicting that increasing the lambda values **deteriorates** the performance of the model.

L2 GRAD DESC
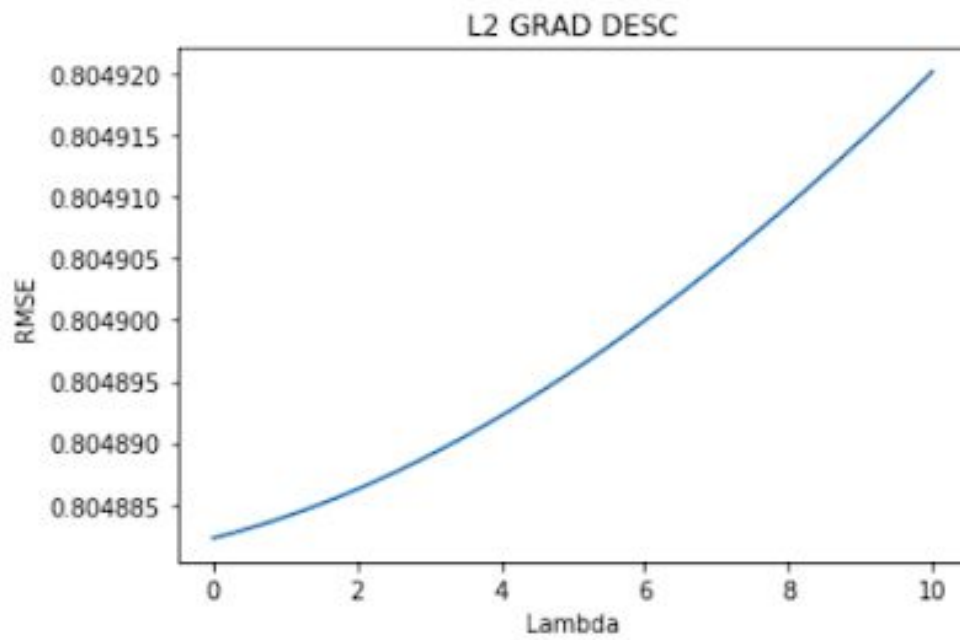
Furthermore, we find that the performance of the 6th degree polynomial is **better** than those of the lower degree. Hence we can conclude that 6th degree polynomial suits better for the dataset.