In [119]:

```
from sklearn.datasets import load_boston
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import time
```

In [120]:

```
boston = load_boston()
X = boston.data #(506,13)
y = boston.target #(506,)
```

In [121]:

```
#print(boston.feature_names)
#print(boston.DESCR)

df = pd.DataFrame(X)
df.columns = boston.feature_names
df.head()
#df.describe()
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT
0	0.00632	18.0	2.31	0.0	0.538	6.575	65.2	4.0900	1.0	296.0	15.3	396.90	4.98
1	0.02731	0.0	7.07	0.0	0.469	6.421	78.9	4.9671	2.0	242.0	17.8	396.90	9.14
2	0.02729	0.0	7.07	0.0	0.469	7.185	61.1	4.9671	2.0	242.0	17.8	392.83	4.03
3	0.03237	0.0	2.18	0.0	0.458	6.998	45.8	6.0622	3.0	222.0	18.7	394.63	2.94
4	0.06905	0.0	2.18	0.0	0.458	7.147	54.2	6.0622	3.0	222.0	18.7	396.90	5.33

In [122]:

```
# Normalising Data
u = np.mean(X, axis = 0)
std = np.std(X, axis = 0)

X = (X - u)/std

df = pd.DataFrame(X)
df.columns = boston.feature_names
df.head()
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX
0	-0.419782	0.284830	-1.287909	-0.272599	-0.144217	0.413672	-0.120013	0.140214	-0.982843	-0.666608
1	-0.417339	-0.487722	-0.593381	-0.272599	-0.740262	0.194274	0.367166	0.557160	-0.867883	-0.987329
2	-0.417342	-0.487722	-0.593381	-0.272599	-0.740262	1.282714	-0.265812	0.557160	-0.867883	-0.987329
3	-0.416750	-0.487722	-1.306878	-0.272599	-0.835284	1.016303	-0.809889	1.077737	-0.752922	-1.106115
4	-0.412482	-0.487722	-1.306878	-0.272599	-0.835284	1.228577	-0.511180	1.077737	-0.752922	-1.106115

In [123]:

```
### Linear Regression
# theta - (13,)
# X = (506,13)
# m - 506, n-13
# Hypothesis Fn - x is a vector, o/p- value
ones = np.ones((X.shape[0],1))
X = np.hstack((ones,X))
def hypothesis(X, theta):
    return np.dot(X, theta)
```

In [124]:

```
# Error Fn- o/p = value
def error(X,y,theta):
    e = 0.0
    m = X.shape[0]
    y_ = hypothesis(X,theta)
    e = np.sum((y-y_)**2)
    return e/m
```

In [125]:

```
# Gradient Fn- o/p = (n,)
def gradient(X,y,theta):
    y_ = hypothesis(X,theta)
    grad = np.dot(X.T,(y_-y))
    m = X.shape[0]
    return grad/m
```

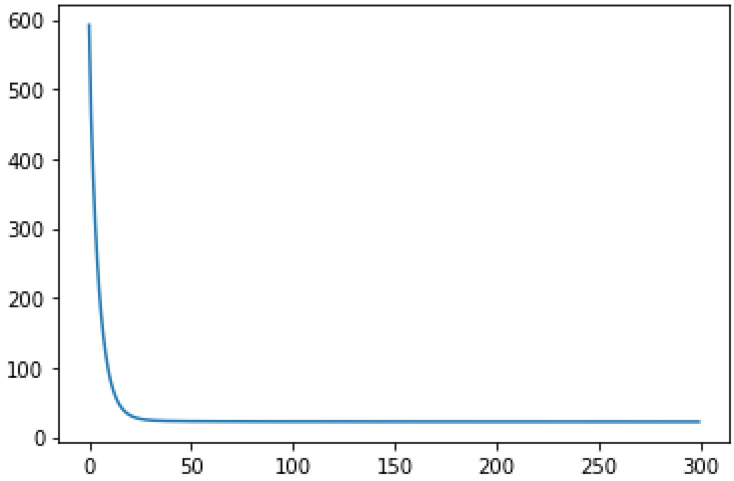
In [126]:

```
# Gradient Descent- o/p = (n,)
def gradient_descent(X,y,learning_rate=0.1, max_epochs=300):

    n = X.shape[1]
    theta = np.zeros((n,))
    error_list = []

    for i in range(max_epochs):
        e = error(X,y,theta)
        error_list.append(e)

        grad = gradient(X,y,theta)
        theta = theta - learning_rate * grad
    return theta, error_list
```

In [127]:

```
start = time.time()
theta, error_list  = gradient_descent(X,y)
end = time.time()
print("Time taken: ",end-start)

plt.plot(error_list)
plt.show()
```

```
Time taken:  0.016954421997070312
```



In [128]:

```
def r2_score(Y, Y_):
    num = np.sum((Y - Y_)**2)
    den = np.sum((Y - Y.mean())**2)
    score = (1-num/den)
    return score*100
```

In [129]:

```
y_ = []
m = X.shape[0]
for i in range(m):
    pred = hypothesis(X[i], theta)
    y_.append(pred)

y_ = np.array(y_)

score = r2_score(y,y_)
print(score)
```

```
74.04541323942742
```

In [ ]:

In [ ]: