ML Report Lab 3

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Linear regression on dataset with 10 values with actual function being sine and normal noise added to y.

import libraries

In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

create dataset

In [2]:

```
# Create dataset
x = np.linspace (0, 2*np.pi, 10)

# Actual function
y = np.sin(x)
```

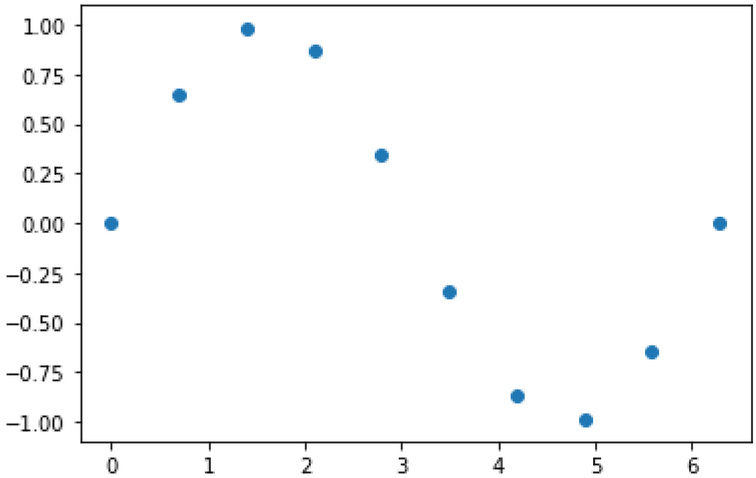
Plot

In [3]:

```
# Plotting the real function (scatter)
plt.scatter (x, y)
```

Out[3]:

```
<matplotlib.collections.PathCollection at 0x7ff15192cfd0>
```



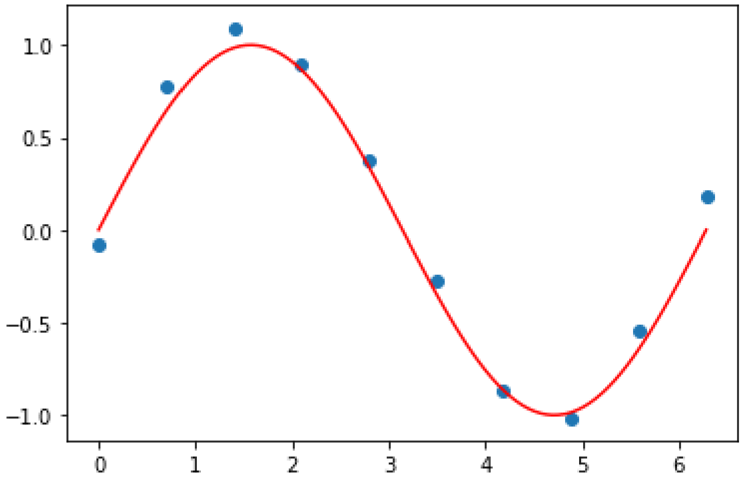
Create data with random normal noise added

In [4]:

```
# Creating dataset with random normal noise added to function
y_true = np.sin (x) + np.random.normal (0,0.09, 10)
```

In [5]:

```
# Plot the real data (noised) with respect to actual sine function
plt.scatter (x, y_true)
val = np.linspace (0,2*np.pi, 100)
plt.plot (val, np.sin (val), color = "red")
plt.show ()
```



A general function which takes data matrix input and passes it through m basis functions to make an M dimension data matrix

In [6]:

```
# General functiont with take x data matrix of D dimension and o order to create
a M dimension data natrix X

def data (x, m):

    df = []
    for i in x:
        z = []
        for j in range (m):
            z.append (i**j)
        df.append (z)

    df = pd.DataFrame (df)
    return df
```

In [7]:

```
# Create data frame of data x with order 5 (passing through 5 ba)
df = data (x, 5)
df
```

Out[7]:

	0	1	2	3	4
0	1.0	0.000000	0.000000	0.000000	0.000000
1	1.0	0.698132	0.487388	0.340261	0.237547
2	1.0	1.396263	1.949551	2.722087	3.800751
3	1.0	2.094395	4.386491	9.187045	19.241302
4	1.0	2.792527	7.798206	21.776699	60.812016
5	1.0	3.490659	12.184697	42.532615	148.466836
6	1.0	4.188790	17.545963	73.496360	307.860831
7	1.0	4.886922	23.882006	116.709497	570.350197
8	1.0	5.585054	31.192824	174.213593	972.992256
9	1.0	6.283185	39.478418	248.050213	1558.545457

In [ ]:

```

```

General function which takes the data matrix X and actual output Y as input and finds M dimensional weight matrix or parameters of the hypothesis function using matrix multiplication

$$W = ((X^T X)^{-1} X^T Y)$$

In [8]:

```
def find_weights (X, Y):

    rhs = np.matmul (X.T, Y)
    lhs = np.matmul (X.T, X)

    return np.matmul (np.linalg.inv (lhs), rhs)
```

General Linear Regression function which takes X data matrix, Y actual value and Dimension m of the hyothesis to be fit on the data. It plots the fit.

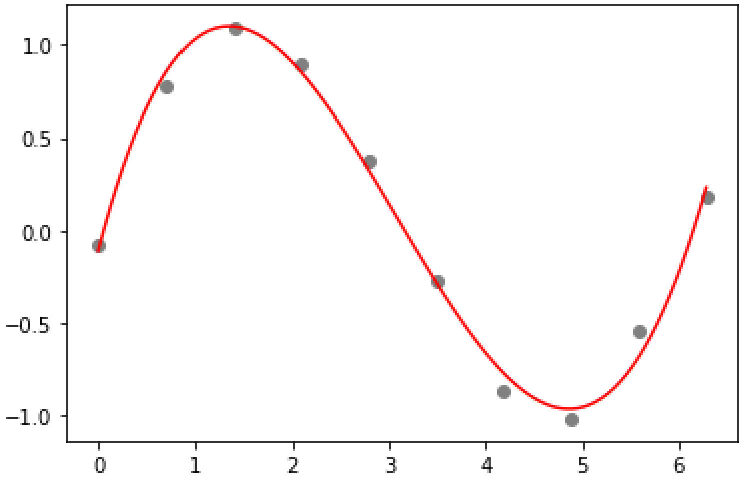
In [9]:

```
def linear_regression (x, y, m):

    df = data (x, m)
    w = find_weights (df.values, y)

    plt.scatter (x, y, color = "grey")
    val = np.linspace (min (x), max(x), 100)
    plt.plot (val, np.matmul (data (val, m).values, w), color = "red")

    return w
```

Curve with dimension 5 fitting the data we created (noised)

In [10]:

```
w = linear_regression (x, y_true, 5)
```



Green - Predicted values for given x using our hypothesis

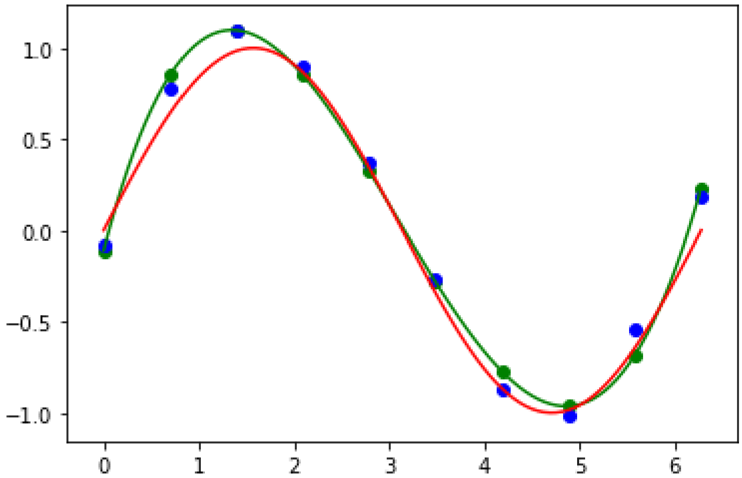
Red - Actual Function

Blue points - Our training dataset

Green points - Predicted value for training data x using hypothesis

In [11]:

```
plt.scatter (x, np.matmul(df.values, w), color= "green")
val = np.linspace (0, 2*np.pi, 100)
plt.plot (val, np.matmul (data (val, 5).values, w), color = "green")
plt.scatter (x, y_true, color="blue")
plt.plot (val, np.sin (val), color = "red")
plt.show ()
```



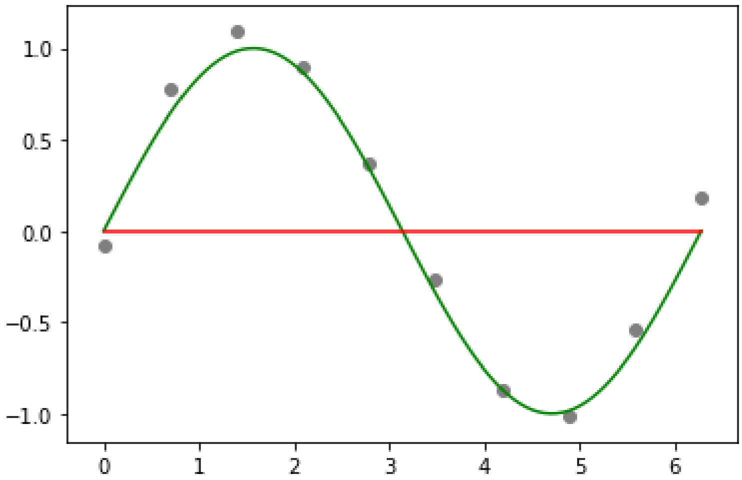
Fitting a curve with different order of hypothesis function using Linear Regression

Plot for different values of m

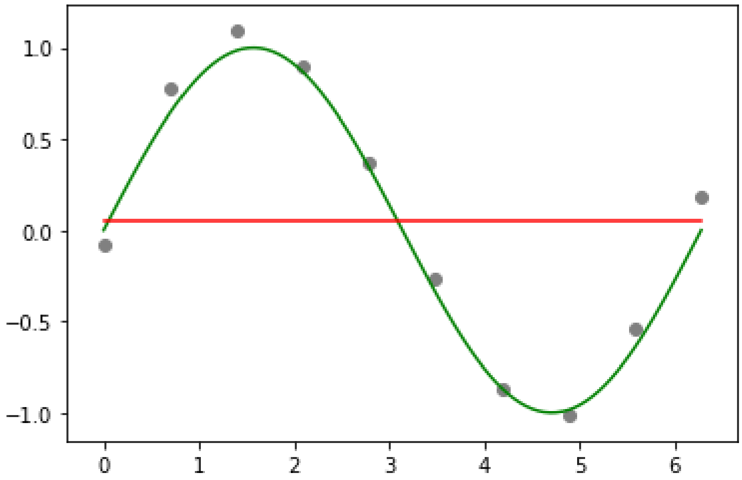
In [16]:

```
val = np.linspace (0, 2*np.pi, 100)

for i in range (0, 11):
    print ("\n\n")
    print ("Degree: ", i)
    # Actual line
    plt.plot (val, np.sin (val), color = "green")

    # Derived line
    linear_regression (x, y_true, i)
    plt.show ()
```

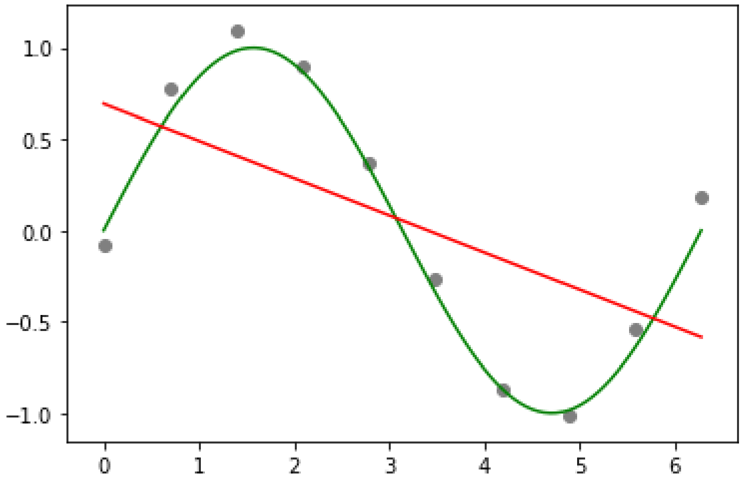
```
Degree:  0
```



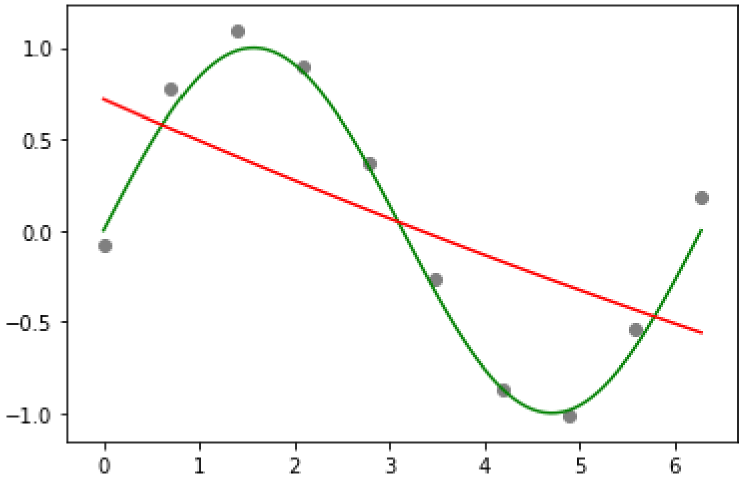

```
Degree:  1
```



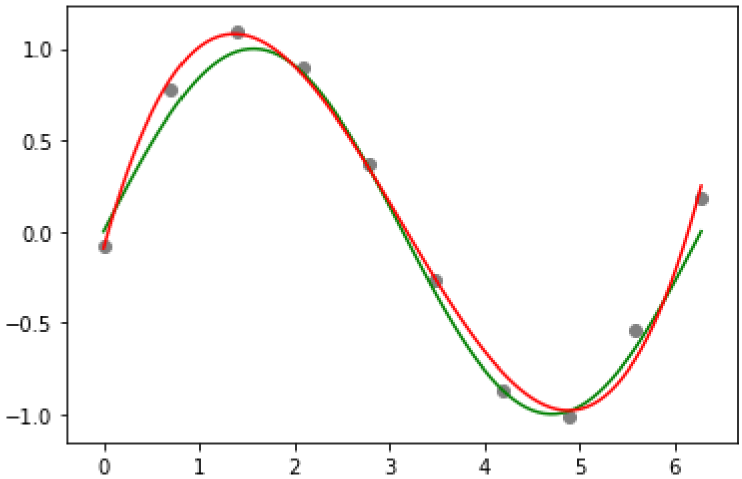

```
Degree:  2
```



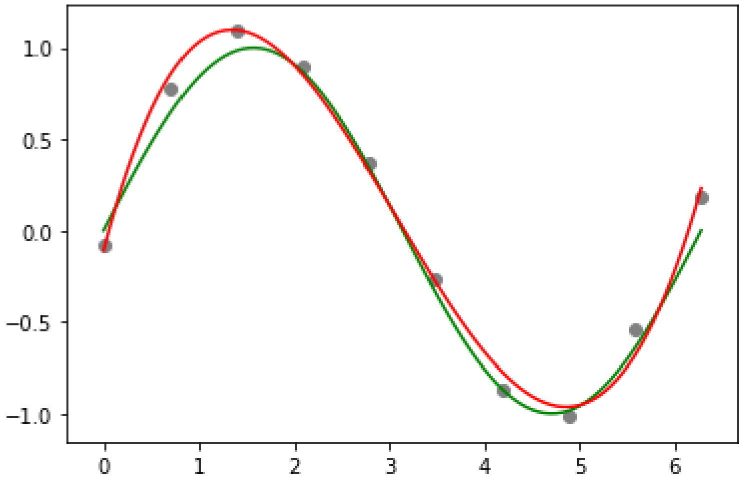

```
Degree:  3
```



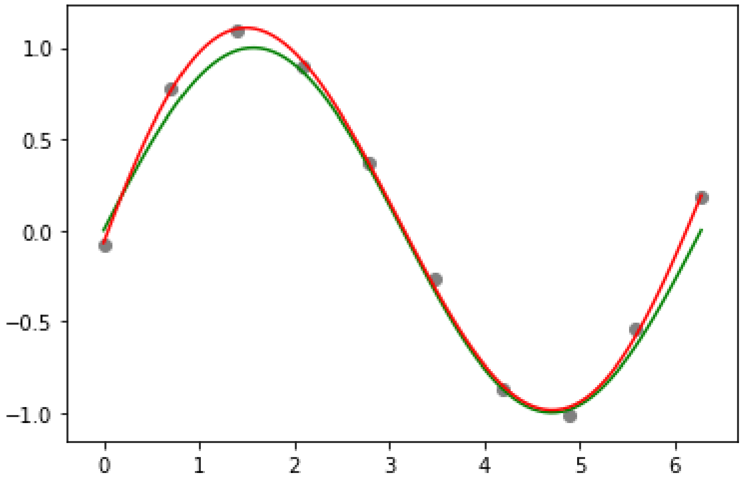

```
Degree:  4
```



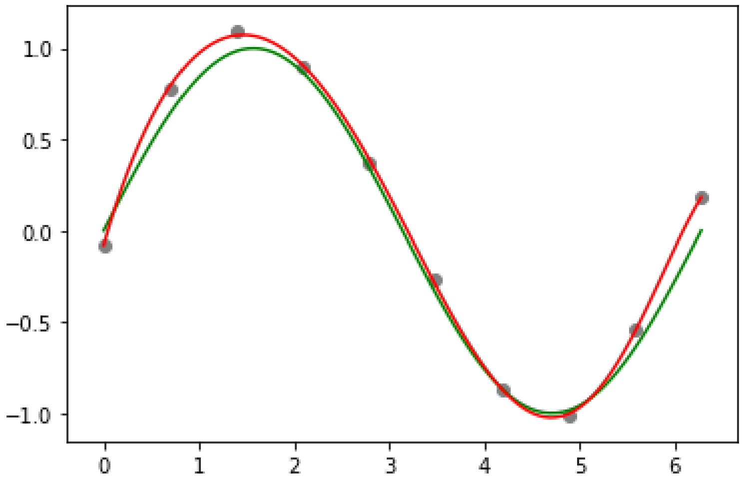

```
Degree:  5
```



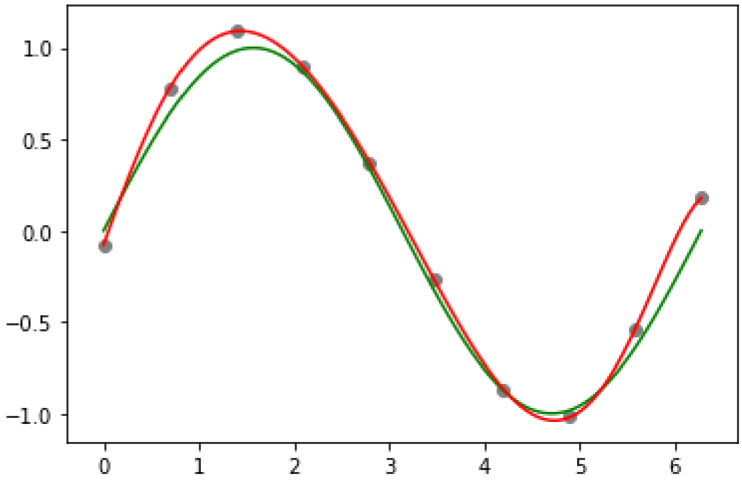

```
Degree:  6
```



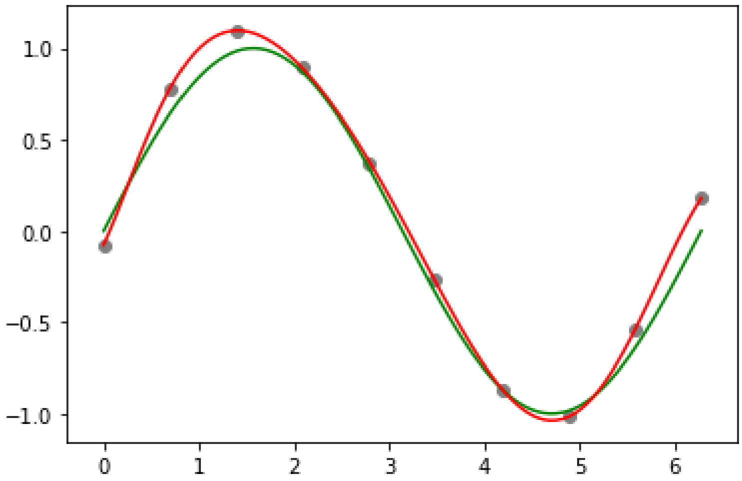

```
Degree:  7
```




```
Degree:  8
```



Degree: 9



Degree: 10