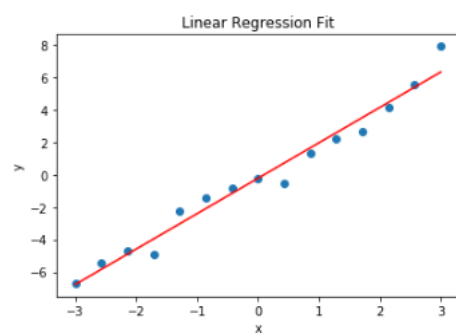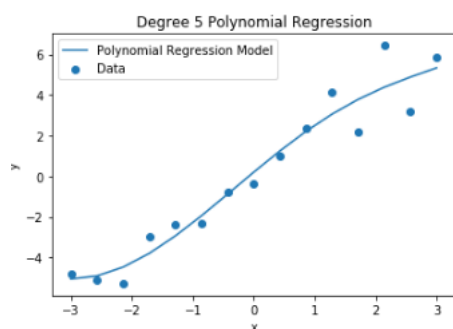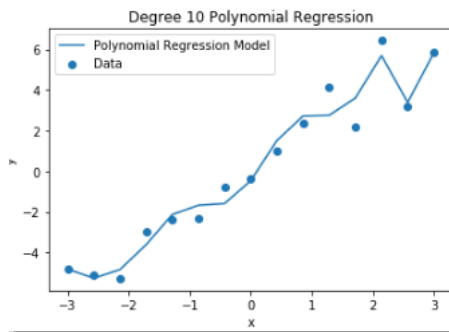# Q1

Q2


```
Training Error: 0.49017809305031185
Cross-Validation Error: 0.6824192588020899
```

Q3

Training Error (degree 5): 0.8900

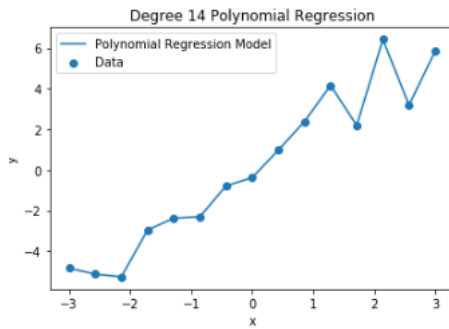Cross-Validation Error (degree 5): 5.1022

Training Error (degree 10): 0.4456

Cross-Validation Error (degree 10): 6992.5243

Degree 10 Polynomial Regression
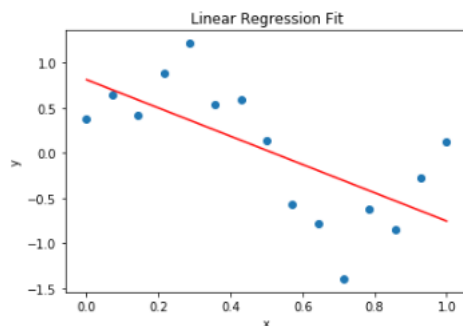
Training Error (degree 14): 0.0000
Cross-Validation Error (degree 14): 23990651.3930

Degree 14 Polynomial Regression

Q4

```
1    def model4(n_samples):
2        # Generate random values of x between 0 and 1
3        x = np.linspace(0, 1, n_samples)
4
5        # Generate the target variable y as sin(2πx) with Gaussian noise ε~ N(0, 0.04)
6        y = np.sin(2 * np.pi * x) + np.random.normal(0, 0.2, n_samples)
7
8        return x, y
```
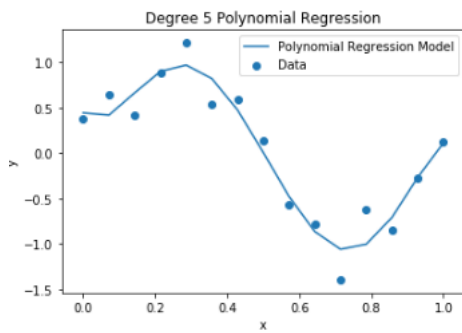
linear regression

Linear Regression Fit

```
Training Error: 0.28089785581142124
Cross-Validation Error: 2.991727956077943
```

polynomial regression

Training Error (degree 5): 0.0382
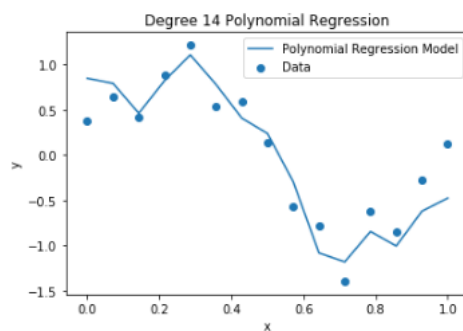Cross-Validation Error (degree 5): 0.1735

Degree 5 Polynomial Regression

Training Error (degree 10): 0.0202
Cross-Validation Error (degree 10): 704.7600

Degree 10 Polynomial Regression
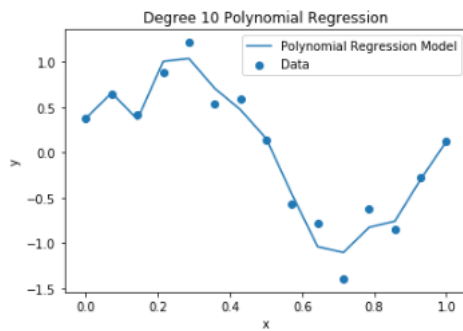
Training Error (degree 14): 0.0748
Cross-Validation Error (degree 14): 15055.1879

Degree 14 Polynomial Regression

Q5

Training Error (degree 14): 0.1503
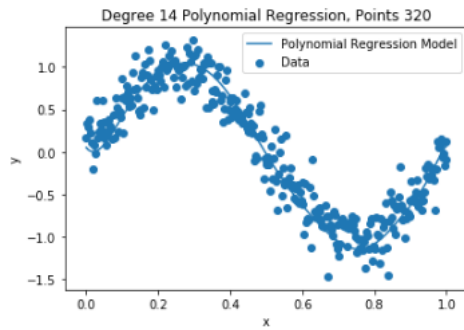Cross-Validation Error (degree 14): 308.8500

Degree 14 Polynomial Regression, Points 10
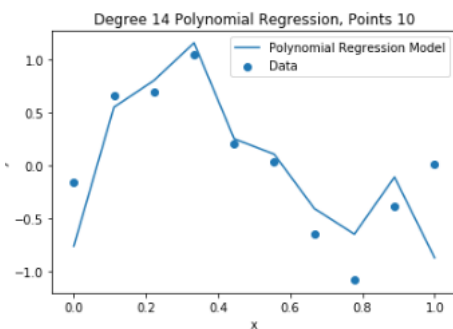
Training Error (degree 14): 0.1895
Cross-Validation Error (degree 14): 0.1761

Degree 14 Polynomial Regression, Points 80
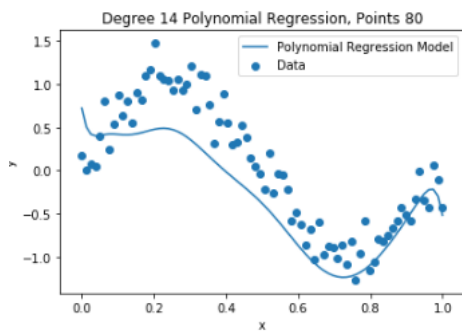
Training Error (degree 14): 0.0438
Cross-Validation Error (degree 14): 0.0569

Degree 14 Polynomial Regression, Points 320

Q6

Polynomial Regression with Regularization ($\lambda = 0$)

Five-Fold Cross-Validation Errors

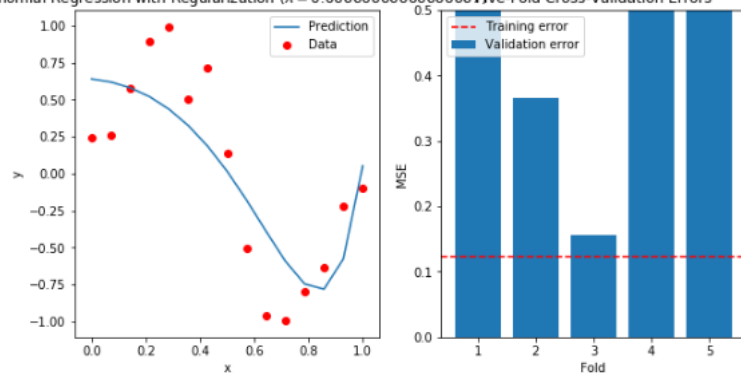Polynomial Regression with Regularization ($\lambda = 6.666666666666667e-05$)

Five-Fold Cross-Validation Errors
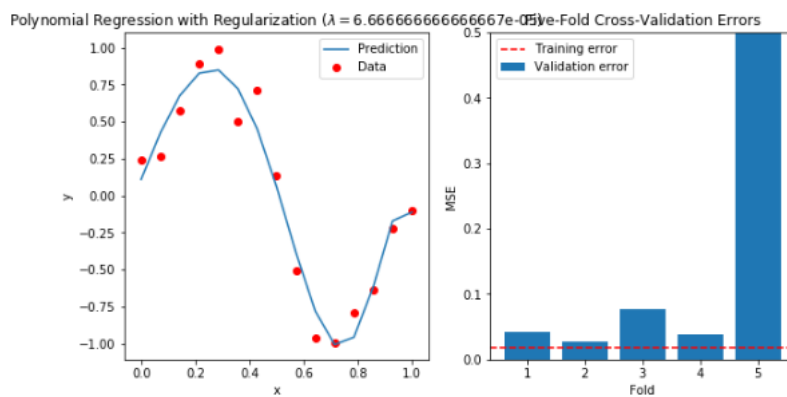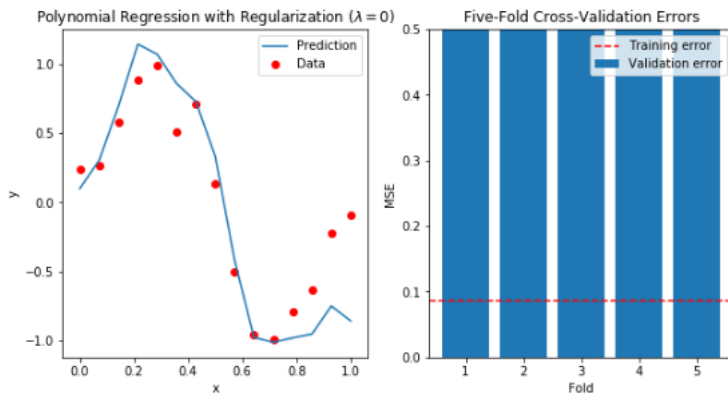
Polynomial Regression with Regularization ($\lambda = 0.06666666666666667$) Five-Fold Cross-Validation Errors

Polynomial Regression with Regularization ($\lambda = 66.66666666666667$) Five-Fold Cross-Validation Errors