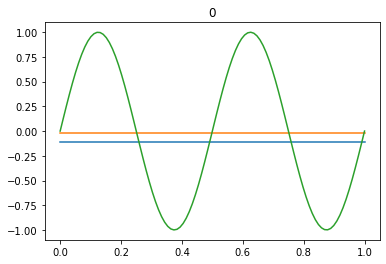
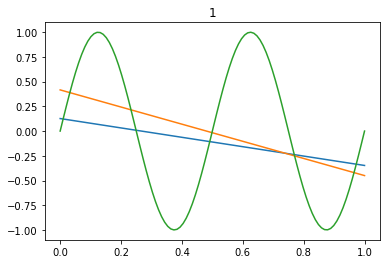
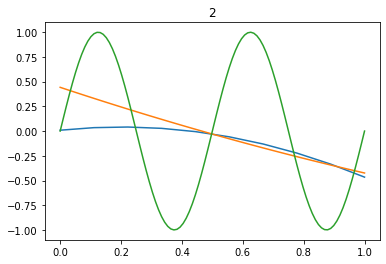
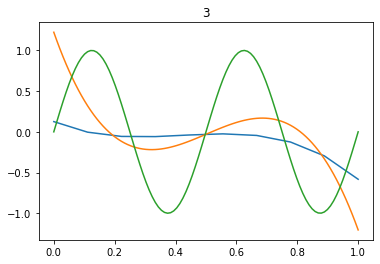
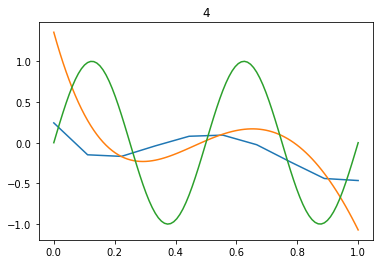
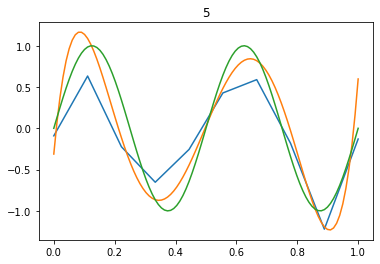
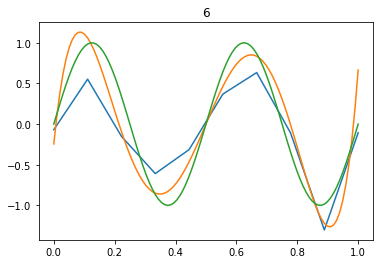
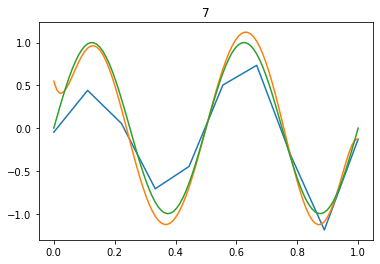
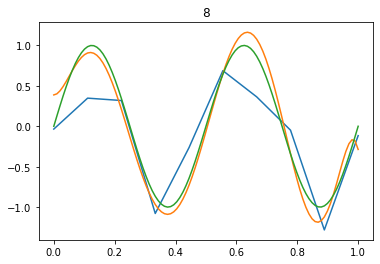
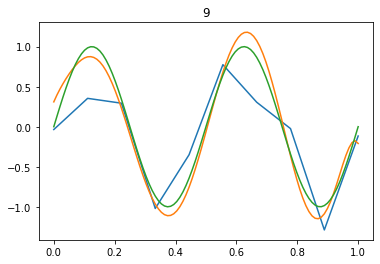
Lab 1 4SL3:

David Wang

400073796

**Part 1**

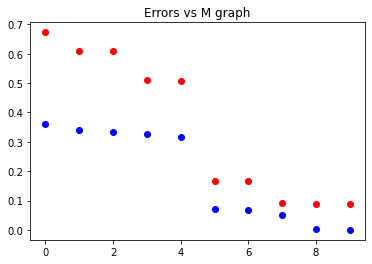
**Plots for training, validation and true functions**

Let it be noted that the blue plot represents the training function, the orange plot represents the validation function and the green plot represents the true function

As can be viewed above, for M=9 value there was no overshooting issues at all, due to this behavior there was no reason to find lambda values to try to compensate for the overshooting issue. Thus this part was skipped in the procedure.

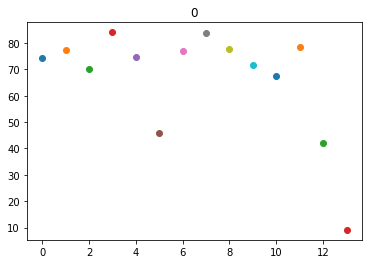
**Plot for comparing error values as M increases.**

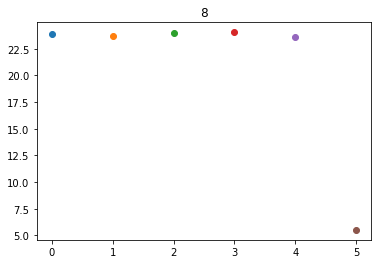
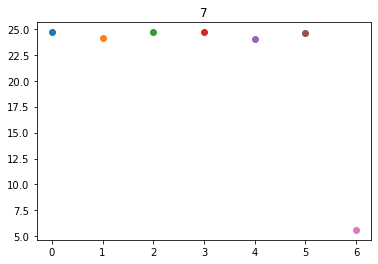
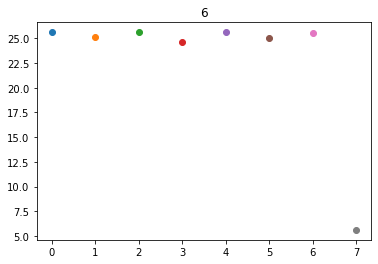
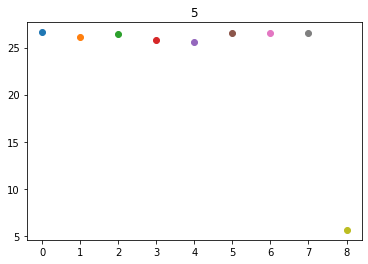
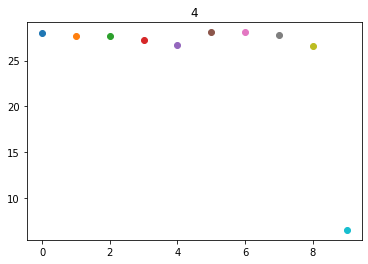
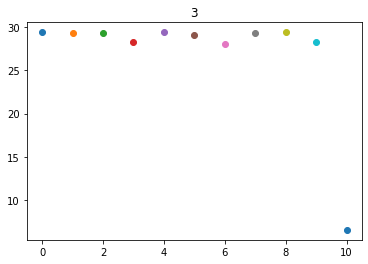
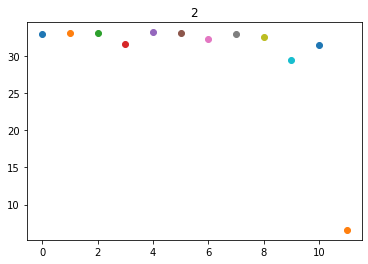
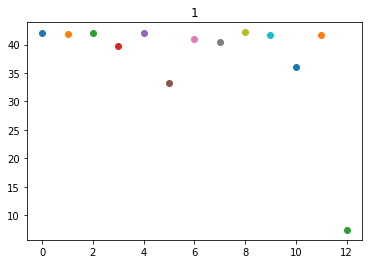
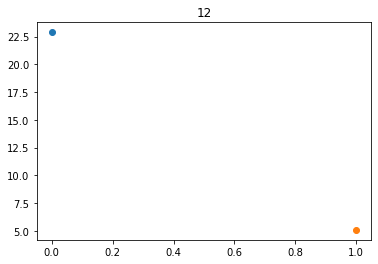
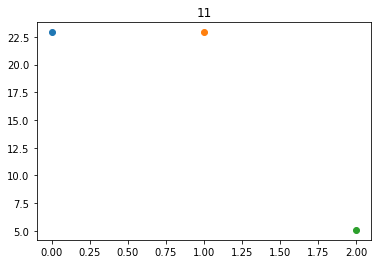
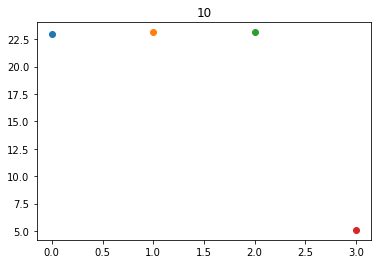
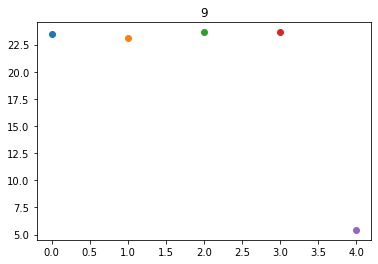


As can be observed from the figure above, the training errors are marked in blue and the validation errors are marked in red. It can be observed that the predictor functions increase dramatically after M=5 but remain relatively inaccurate before the fifth iteration.

**Part 2**

**Errors for no basis expansion**

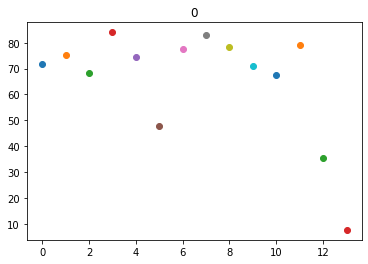
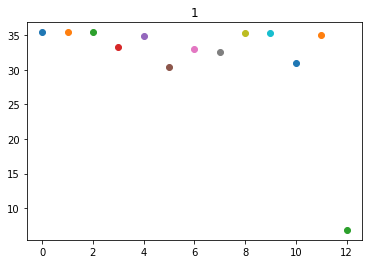


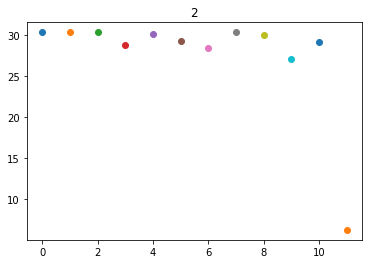
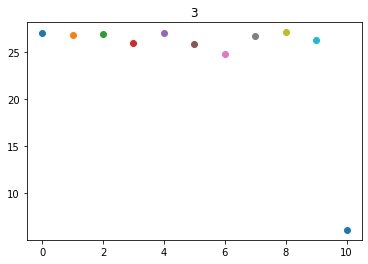
as

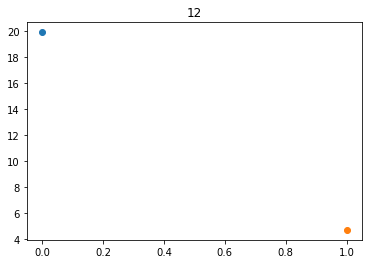
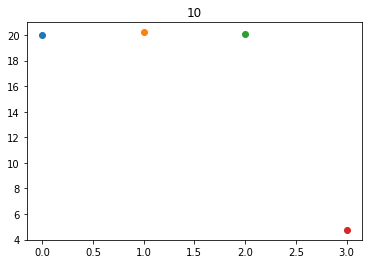
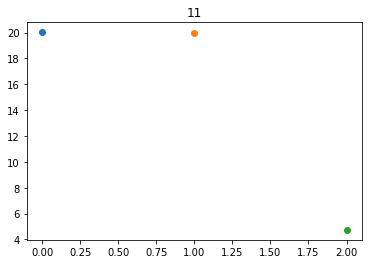
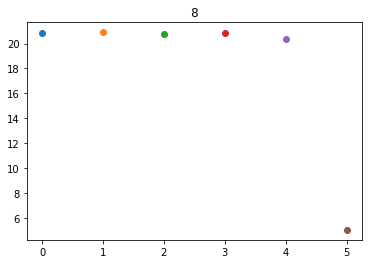
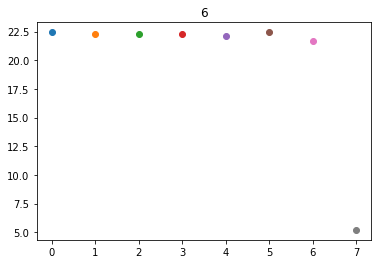
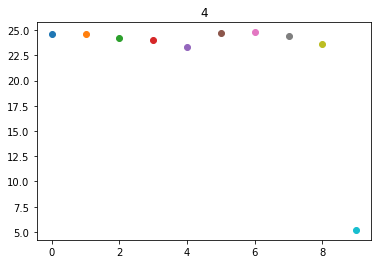
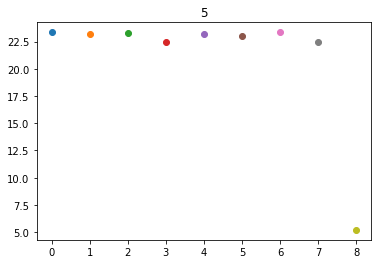
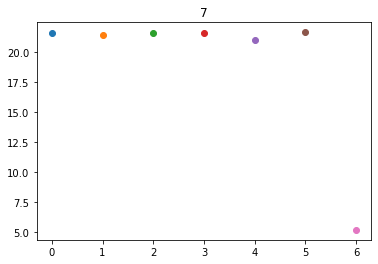
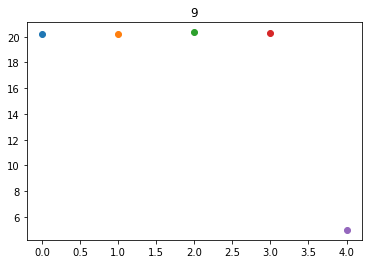
As can be observed, the testing error in all graphs are much smaller than the cross validation errors of all the iterations of S. The training error is always on the most right side of all graphs. The minimum cross fold error and training error is achieved on iteration S=12, also known as the last iteration. Shown below is the minimum cross fold error followed by the minimum testing error

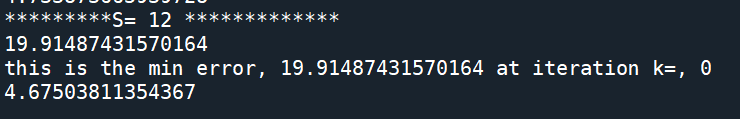


**Errors for basis expansion sqrt(X)**

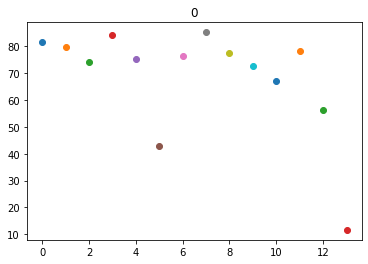
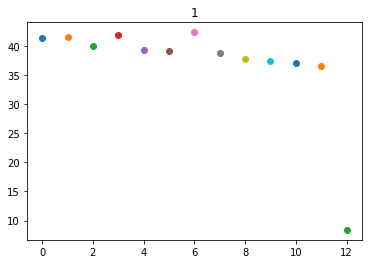
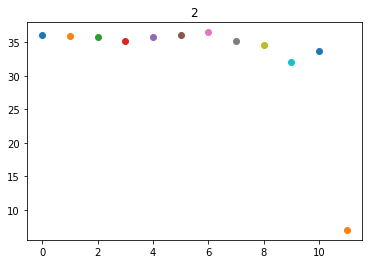
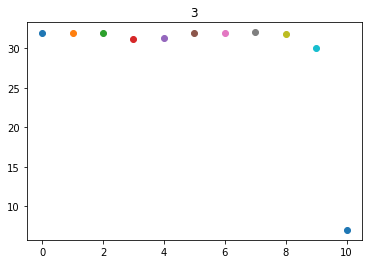
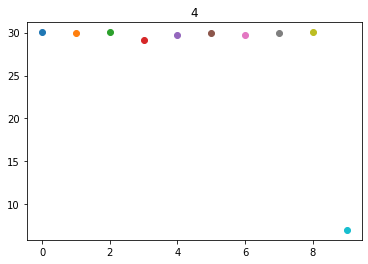
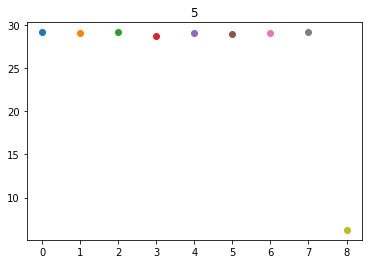
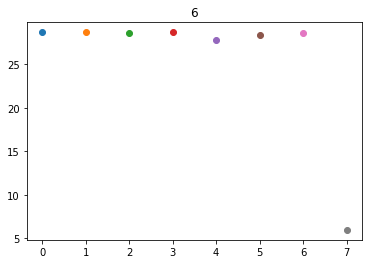
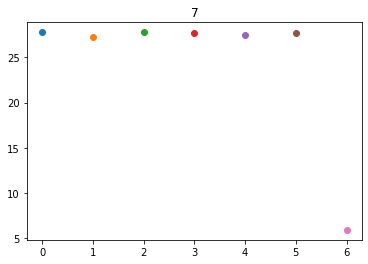
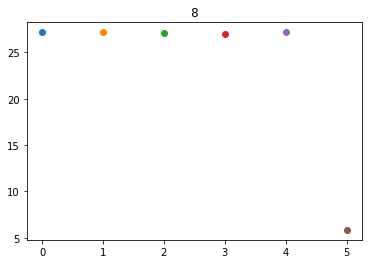
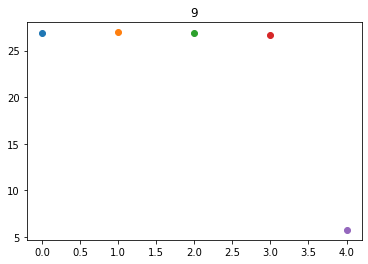
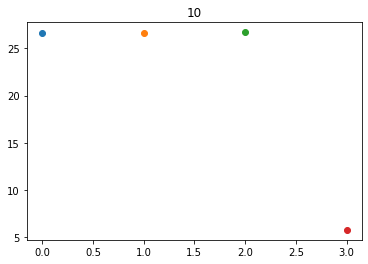
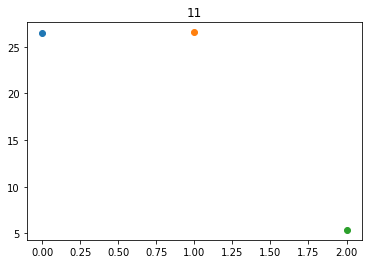
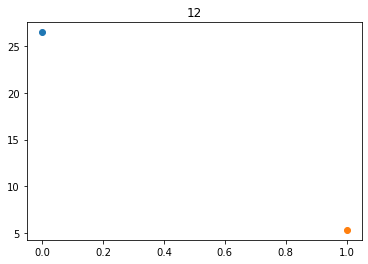






As can be observed, the testing error in all graphs are much smaller than the cross validation errors of all the iterations of S. The training error is always on the most right side of all graphs. The minimum cross fold error and training error is achieved on iteration S=12, also known as the last iteration. This basis expansion method was chosen since it provided a smaller error than the original no basis expansion model, which can be shown from the screen shot below. 

**Errors for basis expansion x^2**

As can be observed, the testing error in all graphs are much smaller than the cross validation errors of all the iterations of S. The training error is always on the most right side of all graphs. The minimum cross fold error and training error is achieved on iteration S=12, also known as the last iteration. This series of models also ended up generating the most error out of the other two.

**Basis Expansion choices**

The square root of x and the square of x were used for basis expansion in this project because I wanted to test the effect of changing the power of the variable in both directions to see the impact of the error and if the model was more precise if the values of x were slightly altered.