Week 3

We are going to be working on worksheet 2. This is a long worksheet, make sure you are able to work on problems with both Lagrange and Newton polynomials.

Starting next week, I will be tracking lab attendance.

You can change your matlab path to work out of your personal directory instead of the local computer lab machine you are on.

A pdf version of this should be uploaded to d2l at some point this evening. But it is good to try the questions with out the hints first. To practice identifying what tools to apply.

Question 1

This is a calculation that we are going to be computing many times. So it would be efficent to create a function.

What are the inputs of the function going to be?

Below is a function you could complete. The ____ areas have been removed.

```
function [Lx] = myLagrange(n,j,xp,x_range)
    Lx=ones(1,___);
    for i =0:n
        if i ~= j
            Lx=Lx.*(x_range-___)/(___-___);
        end
    end
end
```

where xp is the array of x_0 to x_n

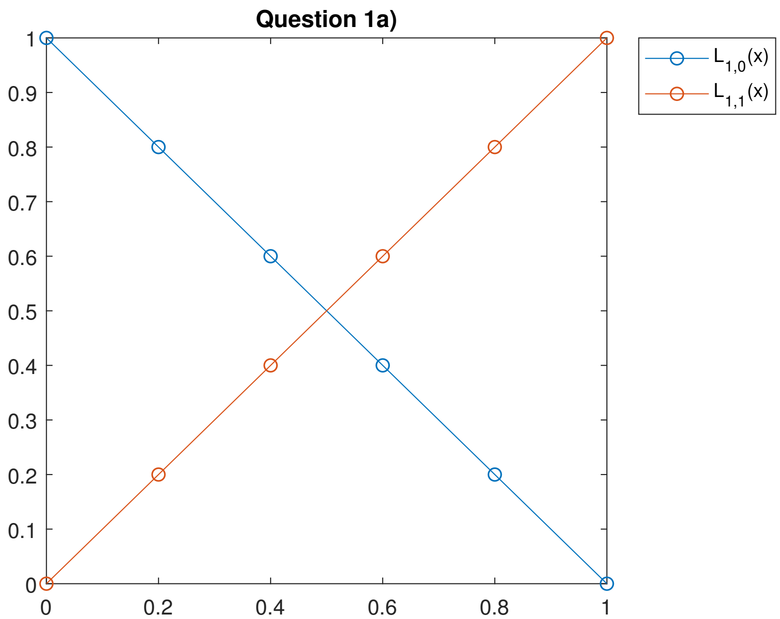
and x_range is the range of x to calculate over

Why is it important to have a different array for xp and x_range?

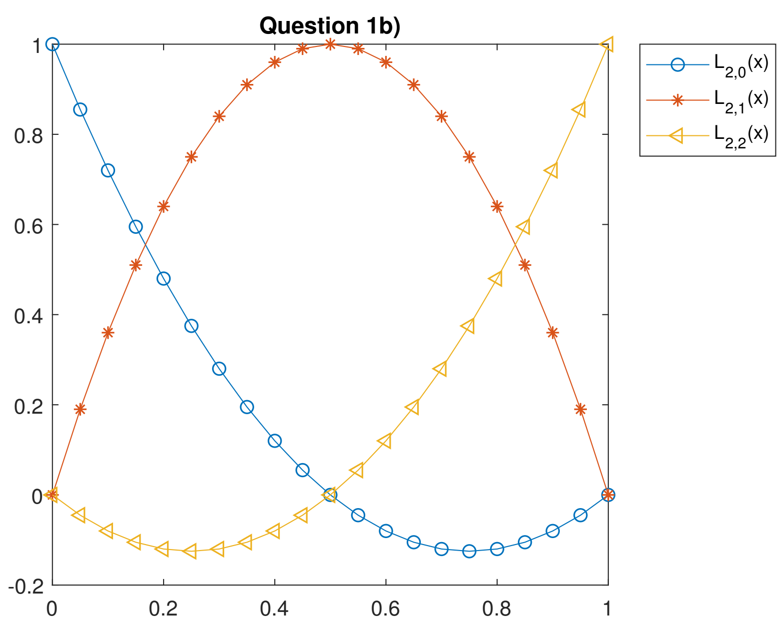
Question 1a)

You will need a section of code to call the function you created. The following is used to create the next figure.

```
x_range=linspace(0,1,6); %Creates 6 points
x=[0,1]; %x0 and x1
Lx10=myLagrange(1,0,x,x_range);
Lx11=myLagrange(1,1,x,x_range);
figure
plot(x_range,Lx10,'-o')
hold on
plot(x_range,Lx11,'-o')
legend("L_{1,0}(x)","L_{1,1}(x)",'Location', 'northeastoutside')
title("Question 1a)")
```



Question 1b)



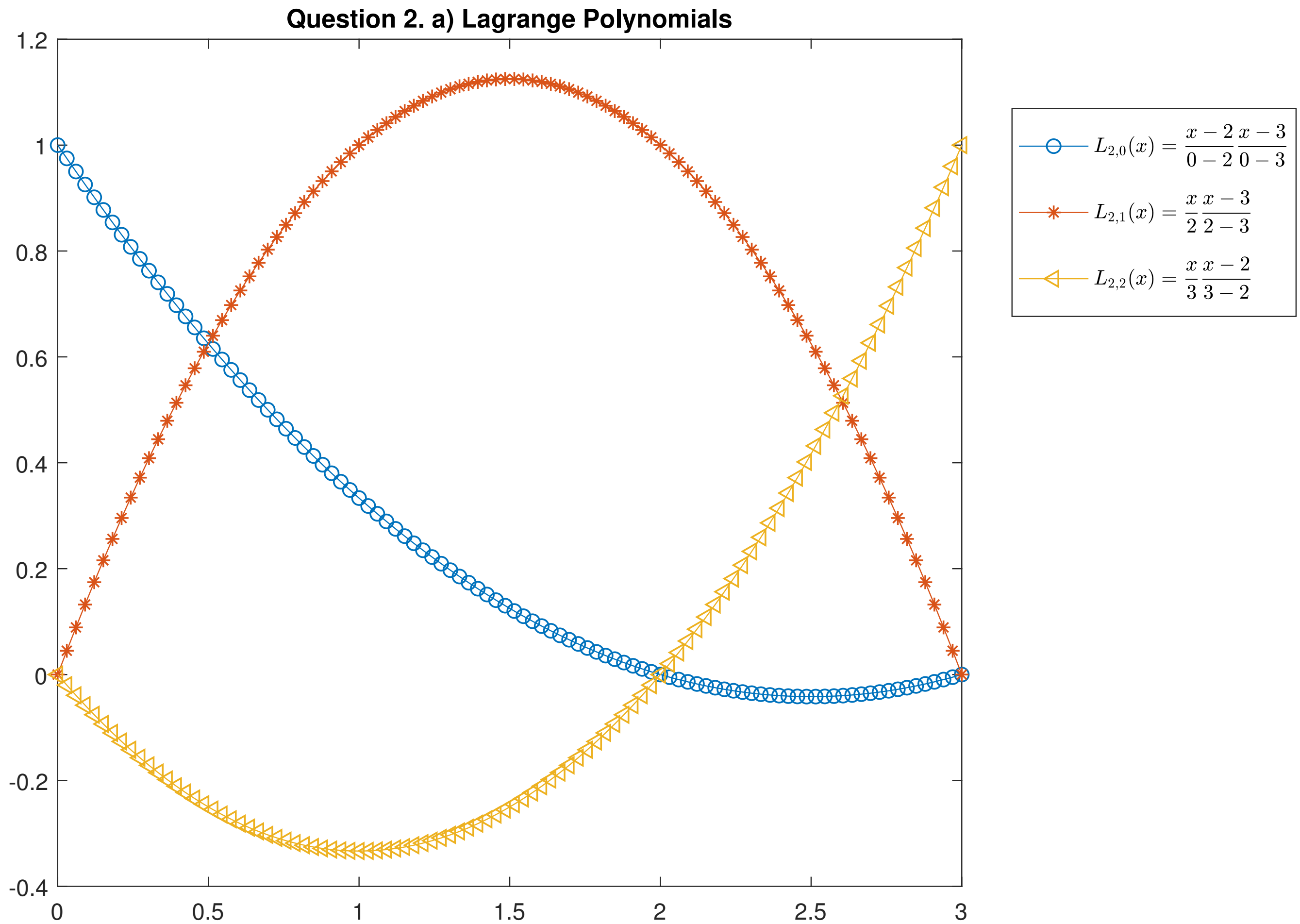
Question 2

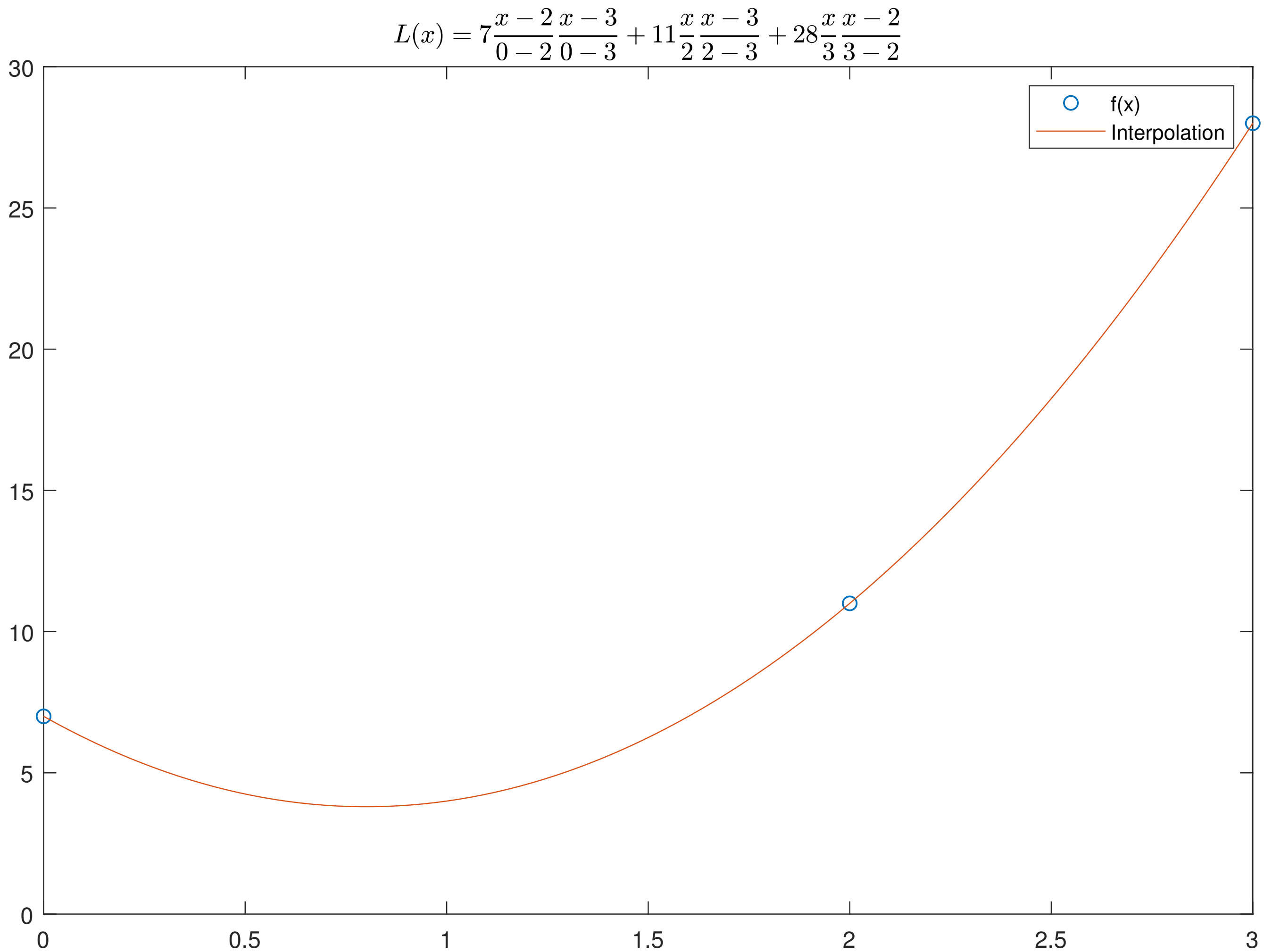
Question just asks for the Lagrange form polynomial. It does not require plotting it. All of the figures here are for your reference to help picture the problem.

Question 2a)

I have included the lines of code used to create the legend:

```
leg1=legend("$$L_{2,0}(x)=\frac{x-2}{0-2}\frac{x-3}{0-3}\\$$","$$L_{2,1}(x)\frac{x}{2}\frac{x-3}{2-3}\\$$"
set(leg1,'Interpreter','latex');
```


Question 2. a) Lagrange Polynomials
$L_{2,0}(x) = \frac{x-2}{0-2}\frac{x-3}{0-3}$
$L_{2,1}(x) = \frac{x}{2}\frac{x-3}{2-3}$
$L_{2,2}(x) = \frac{x}{3}\frac{x-2}{3-2}$
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.5
1
1.5
2
2.5
3



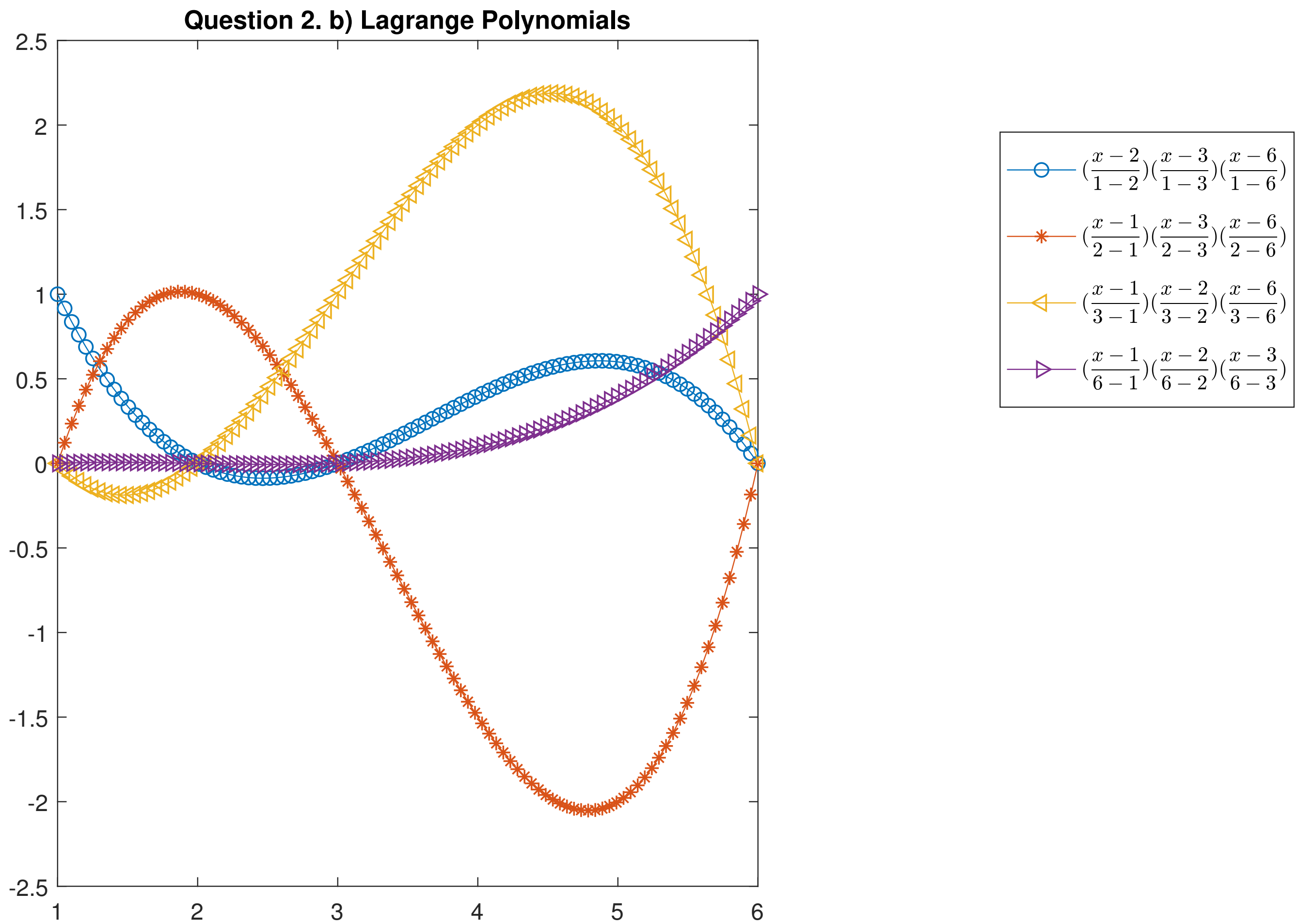
The following line of code was used to create the title:

```
title("$$L(x) = 7 \frac{x-2}{0-2}\frac{x-3}{0-3}+11 \frac{x}{2}\frac{x-3}{2-3}+28 \frac{x}{3}\frac{x-2}{3-
```

The Lagrange form polynomial is of the form:

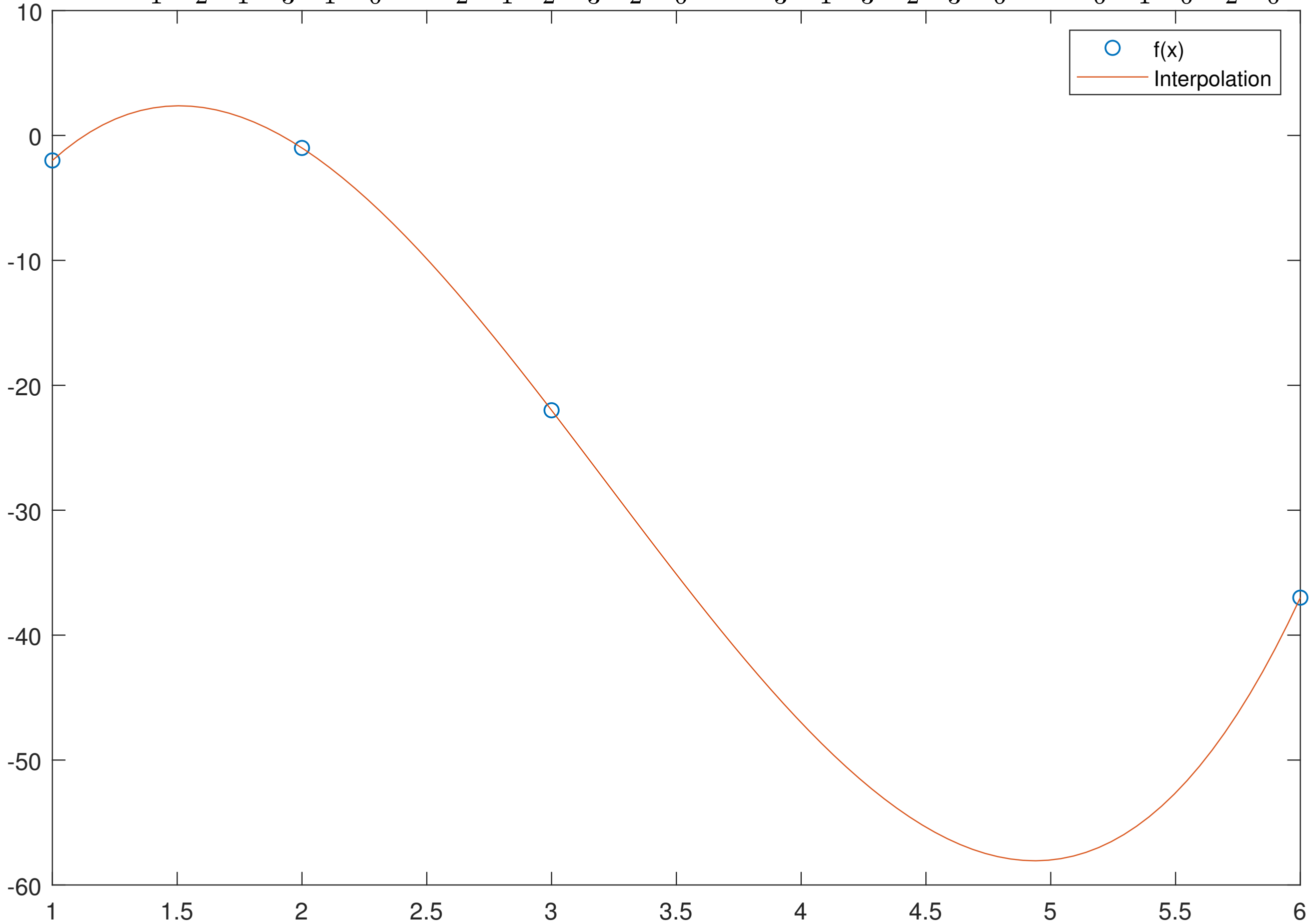
$$L(x) = 7(\frac{2-x}{2})(\frac{3-x}{3}) + 11(\frac{x}{2})(3-x) + 28\frac{x}{3}(x-2)$$

Question 2 b)



Question 2. b) Lagrange Polynomials
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
1
2
3
4
5
6
$(\frac{x-2}{1-2})(\frac{x-3}{1-3})(\frac{x-6}{1-6})$
$(\frac{x-1}{2-1})(\frac{x-3}{2-3})(\frac{x-6}{2-6})$
$(\frac{x-1}{3-1})(\frac{x-2}{3-2})(\frac{x-6}{3-6})$
$(\frac{x-1}{6-1})(\frac{x-2}{6-2})(\frac{x-3}{6-3})$

$$L(x) = -2(\frac{x-2}{1-2})(\frac{x-3}{1-3})(\frac{x-6}{1-6}) - 1(\frac{x-1}{2-1})(\frac{x-3}{2-3})(\frac{x-6}{2-6}) - 22(\frac{x-1}{3-1})(\frac{x-2}{3-2})(\frac{x-6}{3-6}) - 37(\frac{x-1}{6-1})(\frac{x-2}{6-2})(\frac{x-3}{6-3})$$



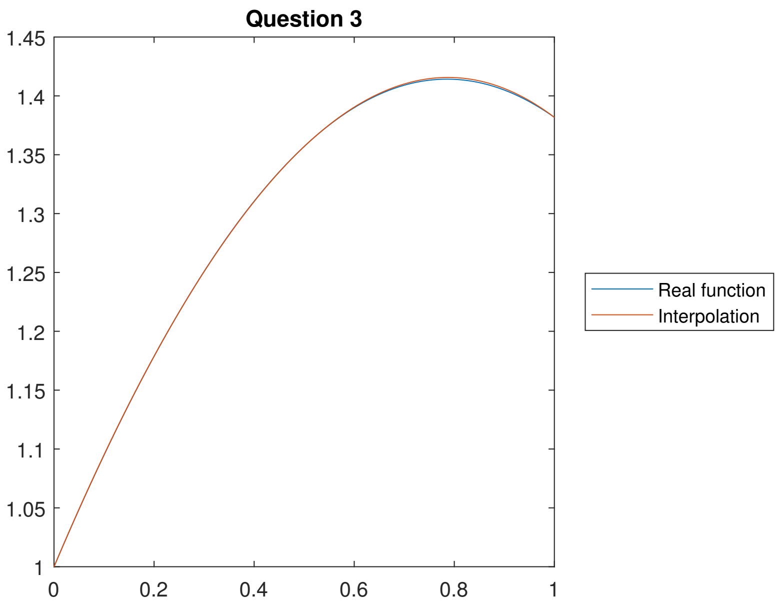
Question 3.

Using the $L_{n,j}$ code from above. Calculating this is quick.

```
Values of x
         0    0.2500    0.5000    1.0000

Values of f(x)
    1.0000    1.2163    1.3570    1.3818

Create a x-axis to display over
This should range from min(x) to max(x) maybe 100 samples?
```

$x\_range = linspace(x(1), x(end))$

```
Calculate L30(x_range) for the points for the x_range
Can create a matrix of L30,L31, etc and multiply by y' to get the interpolated values



Max error on the interval [0,1] is:
    0.0015
```



Question 4

a) similar to the question 3.

b) Find the bound of the error.

Question 5

Divided difference:

$f[x_0] = f(x_0)$

$f[x_0, x_1] = \frac{f(x_1)-f(x_0)}{x_1-x_0}$

$f[x_0, x_1, x_2] = \frac{f[x_1,x_2]-f[x_0,x_1]}{x_2-x_0}$

Question 6

```
For b)
-2-10*(x-1)-11*(x-1)*(x-3)+3*(x-1)*(x-3)*(x-2)
Simplified to:
(3*x - 3)*(x - 2)*(x - 3) - (11*x - 11)*(x - 3) - 10*x + 8
```

Question 7

Can this be solved quickly using either Lagrange or newton method? How else could this information be written?

Question 8

Newton Polynomial expansion.

Question 9

This polynomial looks of the form of a Newton Polynomial. Verify this. To augment the polynomial with another point to get $g(x)$ only requires adding the next term of the newton polynomial to $p(x)$

Question 10

Question 11

Question 12

Repeat of a previous question. Nothing more to do. yay!