ASE 211 Homework 6 Solution

1. Plot the function $f(x) = x^3 \sin(x^5)$ for x between 0 and 4 using the matlab plotting function *plot*. Hint: evaluate the function at 100 points between 0 and 4, and save the values in arrays x and y, then say plot(x,y). Print the resulting figure and hand it in.

```
function plotf(a,b,n)
% function which plots f from a to b using n points
%
h=(b-a)/n;
for i=1:n
  x(i)=a+i*h;
  y(i)=f(x(i));
end
plot(x,y)

function y=f(x)
y=x^3*sin(x^5);

>> plotf(0,4,100)
>> title('plot of f=x^3*sin(x^5)')
```

2. Given the following data

i	x_i	y_i
1	0	4
2	1.1	-1.5
3	1.7	0.5
4	2.2	1.5

First, compute the linear interpolant of the data, then compute the Lagrange interpolant. For both interpolants, give the value at $x = 2$.

The linear interpolant is as follows:
For $0 \le x \le 1.1$:

$$y(x) = 5x - 4.$$

For $1.1 \le x \le 1.7$:

$$y(x) = 3.33(x - 1.1) - 1.5.$$

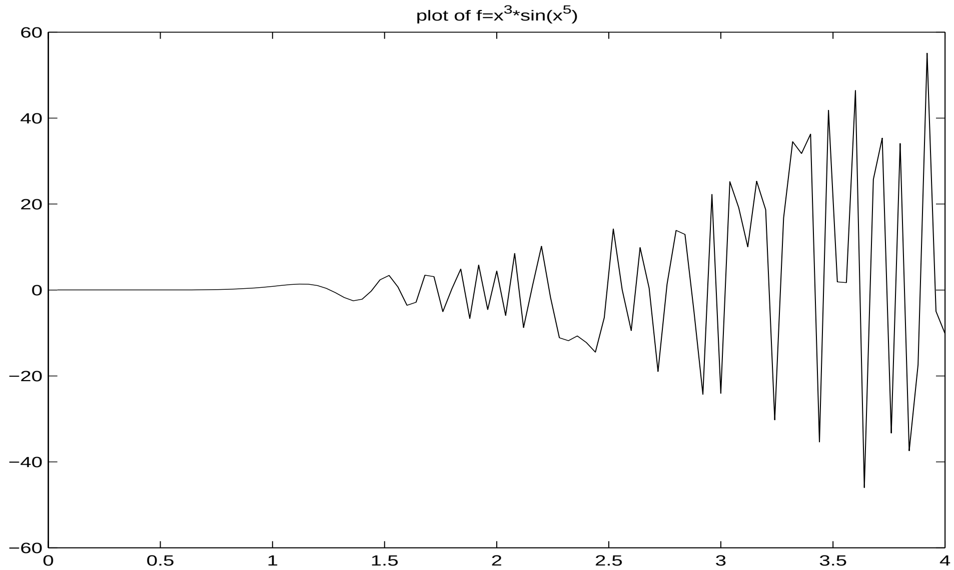

Figure 1: Plot of $f(x) = x^3 \sin(x^5)$

For $1.7 \le x \le 2.2$:

$$y(x) = 2(x - 1.7) + .5.$$

To evaluate the linear interpolant at $x = 2$, since 2 is between 1.7 and 2.2, we get

$$y(2) = 2(2 - 1.7) + .5 = 1.1.$$

For the Lagrange interpolant, we have to compute the coefficients of the cubic polynomial that passes through the points. The linear system is

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1.1 & 1.21 & 1.331 \\ 1 & 1.7 & 2.89 & 4.913 \\ 1 & 2.2 & 4.84 & 10.648 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} = \begin{bmatrix} 4 \\ -1.5 \\ 0.5 \\ 1.5 \end{bmatrix}.$$

Using matlab to solve the system, we get:

$$a_1 = 4, \quad a_2 = -15.5891, \quad a_3 = 12.6835, \quad a_4 = -2.7791.$$

Then

$$P(2) = 4 - 15.5891 * 2 + 12.6835 * 2^2 - 2.7791 * 2^3 = 1.323.$$

3. Write a Matlab code which allows a user to input data points, constructs the Lagrange interpolant, and plots the interpolant over the interval from x_1 to x_n (assuming the data is ordered so that $x_1 < x_2 < \ldots < x_n$.) Test your code on the data in problem A8.2 and plot the approximation to the drag coefficient C_d versus velocity v.

```
function lagrange
n=input('enter number of data points ')
x=input('enter x values ')
y=input('enter y values ')
for i=1:n
for j=1:n
   A(i,j)=x(i)^(j-1);
end
end
a=A\y;
h=(x(n)-x(1))/100;
for k=1:100
   xx(k)=x(1)+h*k;
   yy(k)=0;
   for i=1:n
     yy(k)=yy(k)+a(i)*xx(k)^(i-1);
   end
end
plot(xx,yy)
title('plot of Lagrange interpolant')
```

```
>> lagrange
enter number of data points 5

n =

     5

enter x values [0; 50; 75; 100; 125]

x =

     0
```

```
    50
    75
   100
   125

enter y values [0.5; 0.5; 0.4; 0.28; 0.23]

y =

    0.5000
    0.5000
    0.4000
    0.2800
    0.2300

>> xlabel('velocity')
>> ylabel('drag coefficient')
>> print fig2.ass6.ps
>> diary
```

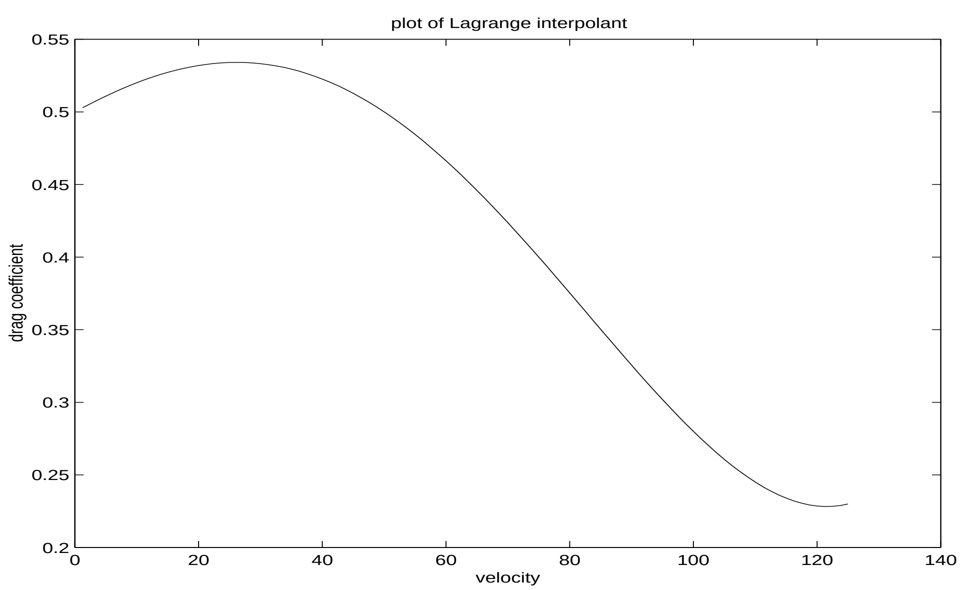

Figure 2: Plot of Lagrange interpolant for velocity vs. drag coefficient