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CSc 301 - HW #3 October 27, 2015

Contents

Problem 1

```
% A car traveling along a straight road is clocked at a number of points. The
% data from the obsercations are given in the following table, where the time
% is in seconds, the distance is in feet, and the speed is in feet per second.

% Time      0   3   5   8   13
% Distance 0   225 383 623 993
% Speed    75 77  80  74  72
```

a. Use a Hermite polynomial to predict the position of the car and it's speed when t = 10s.

```
time     = [ 0;   3;   5;   8;  13];
distance = [ 0; 225; 383; 623; 993];
speed    = [75;  77;  80;  74;  72];

hermite(time, distance, speed);
```

The Hermite polynomial generated by the data in the table is

```
% p(x) = 75x + 0.222222*x^2*(x ? 3) ? 0.0311111*x^2*(x ? 3)^2
%        ? 0.00644444*x^2*(x ? 3)^2*(x ? 5)
%        + 0.00226389*x^2*(x ? 3)^2*(x ? 5)^2
%        ? 0.00091319*x^2*(x ? 3)^2*(x ? 5)^2*(x ? 8)
%        + 0.00013053*x^2*(x ? 3)^2*(x ? 5)^2*(x ? 8)^2
%        ? 0.00002022*x^2*(x ? 3)^2*(x ? 5)^2*(x ? 8)^2*(x ? 13)
```

at t = 10, the position of the car is at ...

```
syms x
p = 75*x + 0.222222*x^2*(x - 3) - 0.0311111*x^2*(x - 3)^2 ...
    - 0.00644444*x^2*(x - 3)^2*(x - 5) ...
    + 0.00226389*x^2*(x - 3)^2*(x - 5)^2 ...
    - 0.00091319*x^2*(x - 3)^2*(x - 5)^2*(x - 8) ...
    + 0.00013053*x^2*(x - 3)^2*(x - 5)^2*(x - 8)^2 ...
    - 0.00002022*x^2*(x - 3)^2*(x - 5)^2*(x - 8)^2*(x - 13);

double(subs(p, x, 10))

% p(10) = 742.5003 approx. 743 feet,
```

```
ans =

  742.5003
```

at t = 10, the value of the speed of the car is ...

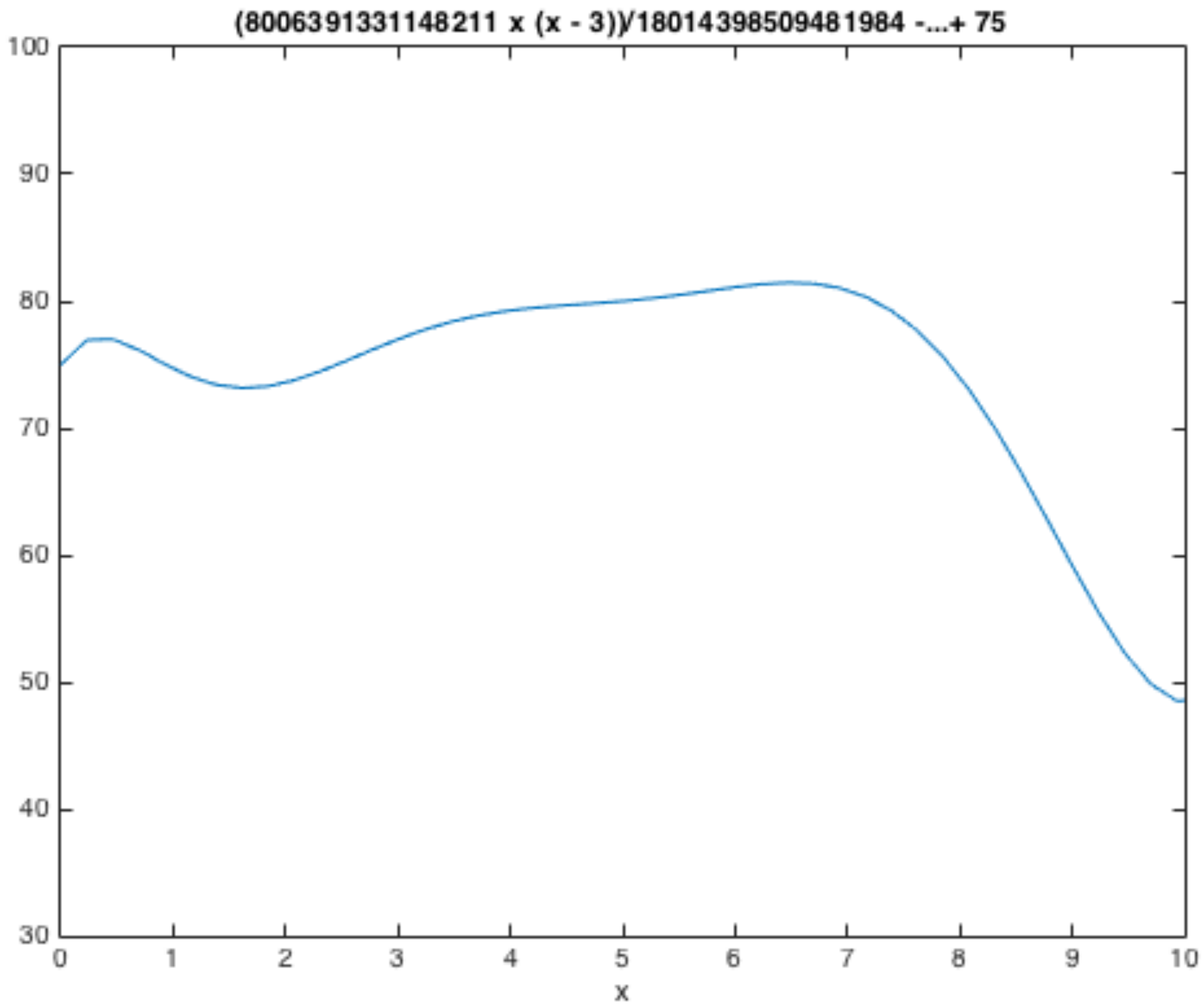
```
p_prime = diff(p);
double(subs(p_prime, x, 10))

% p'(10) = 48.3781 approx. 48 feet/sec.
```

```
ans =

   48.3781
```

b. Use the derivative of the Hermite polynomial to determine whether the car ever exceeds a 55 mph speed limit on the road. If so, what is the first time the car exceeds this speed?

```
% 55 mi/h (80.67 ft/s)
% looking at the graph below, the value exceeds 80.67 ft/s

% approximately, by looking at the graph
% ---------  5.64880 ---------

ezplot(p_prime, [0,10, 30, 100])
double(subs(p_prime, x, 5.64880))
```

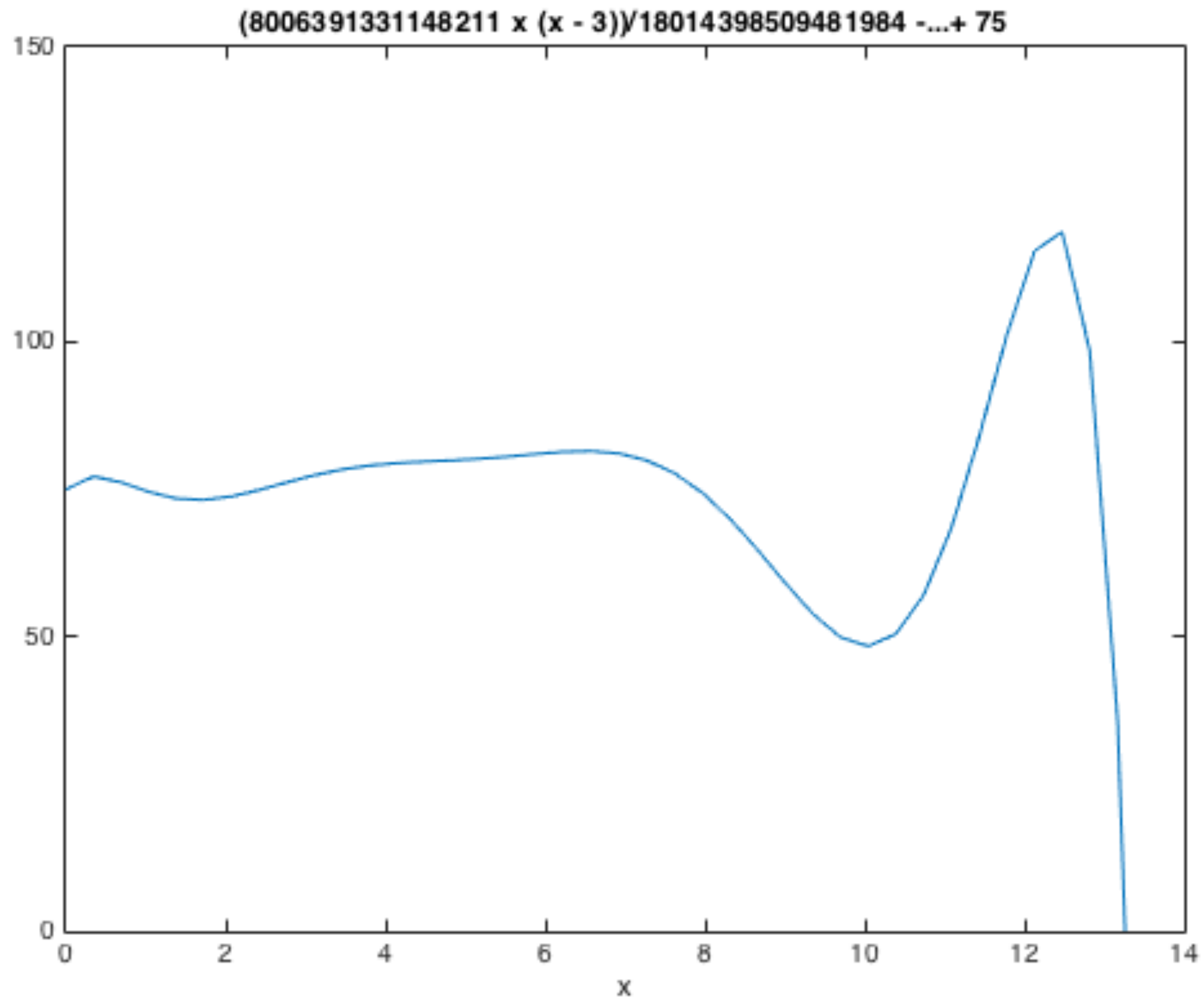
```
ans =

   80.6666
```



c. What is the predicted maximum speed for the car?

```
% looking at the graph of the derivative, the maximum speed of the car occurs somewhere betwee
n t = 12 and t = 13.

ezplot(p_prime, [0, 14, 0, 150])
double(subs(p_prime, x, 12.3737))

% approximately, by looking at the graph
% ---------  12.3737 ---------
% and the speed is about
% --------- 119.4955 ---------
```

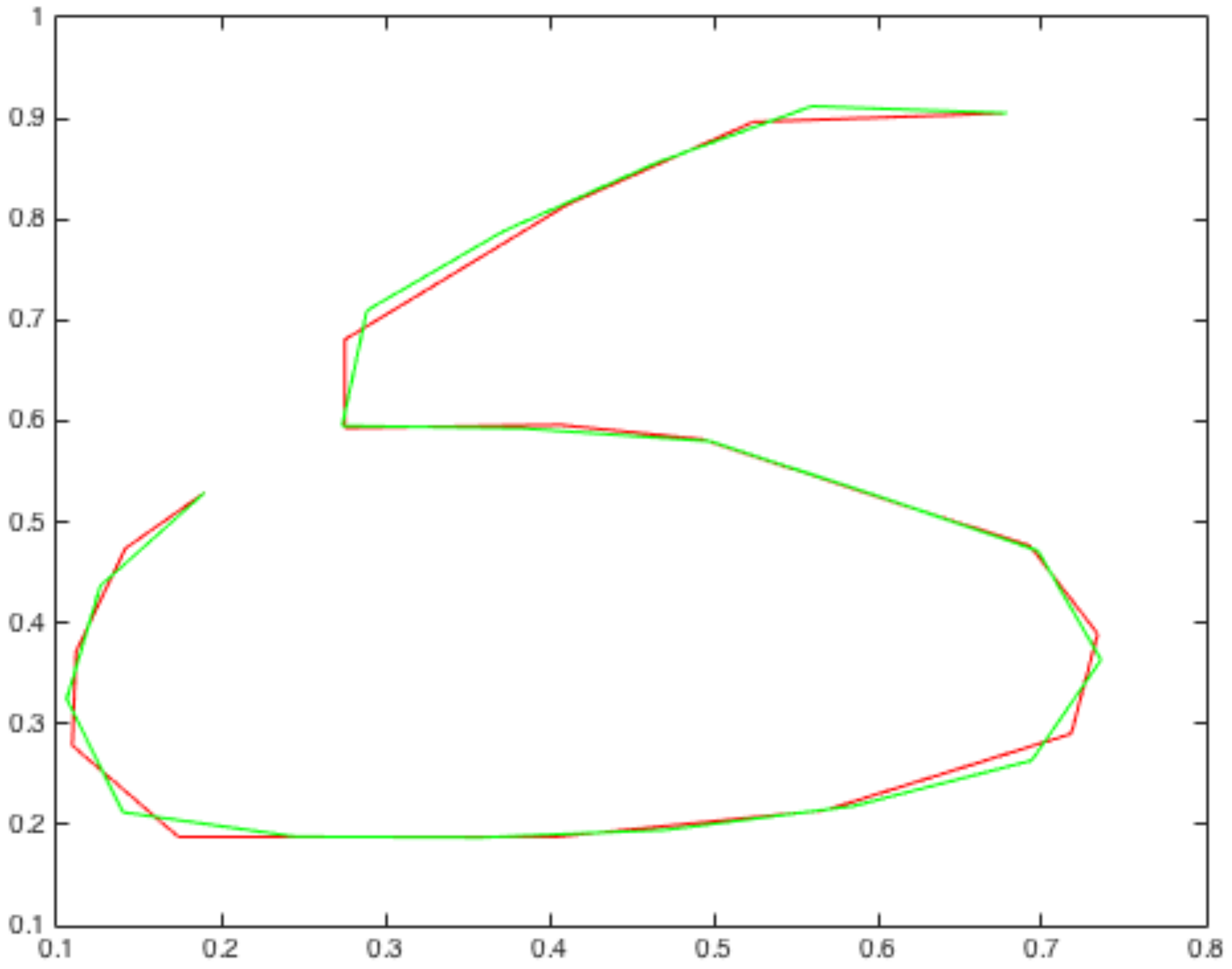
```
ans =

  119.4955
```



Problem 2

```
figure

% m = 20
% [x, y] = ginput(m)

% got the points below using the ginput

x = [0.678571428571429
    0.524193548387097
    0.411290322580645
    0.275345622119816
    0.275345622119816
    0.406682027649770
    0.494239631336406
    0.586405529953917
    0.692396313364055
    0.733870967741935
    0.717741935483871
    0.567972350230415
    0.404377880184332
    0.328341013824885
    0.243087557603687
    0.173963133640553
    0.109447004608295
    0.111751152073733
    0.141705069124424
    0.190092165898617];
```

```
y = [0.905247813411079
   0.896501457725947
   0.814868804664723
   0.680758017492711
   0.593294460641399
   0.596209912536443
   0.581632653061224
   0.532069970845481
   0.476676384839650
   0.389212827988338
   0.290087463556851
   0.214285714285714
   0.188046647230321
   0.188046647230321
   0.188046647230321
   0.188046647230321
   0.278425655976676
   0.371720116618076
   0.473760932944606
   0.529154518950437];

plot(x, y, 'r')
hold on
[xi, yi] = SplineInPlane(x, y, m);
plot(xi, yi, 'g')
```

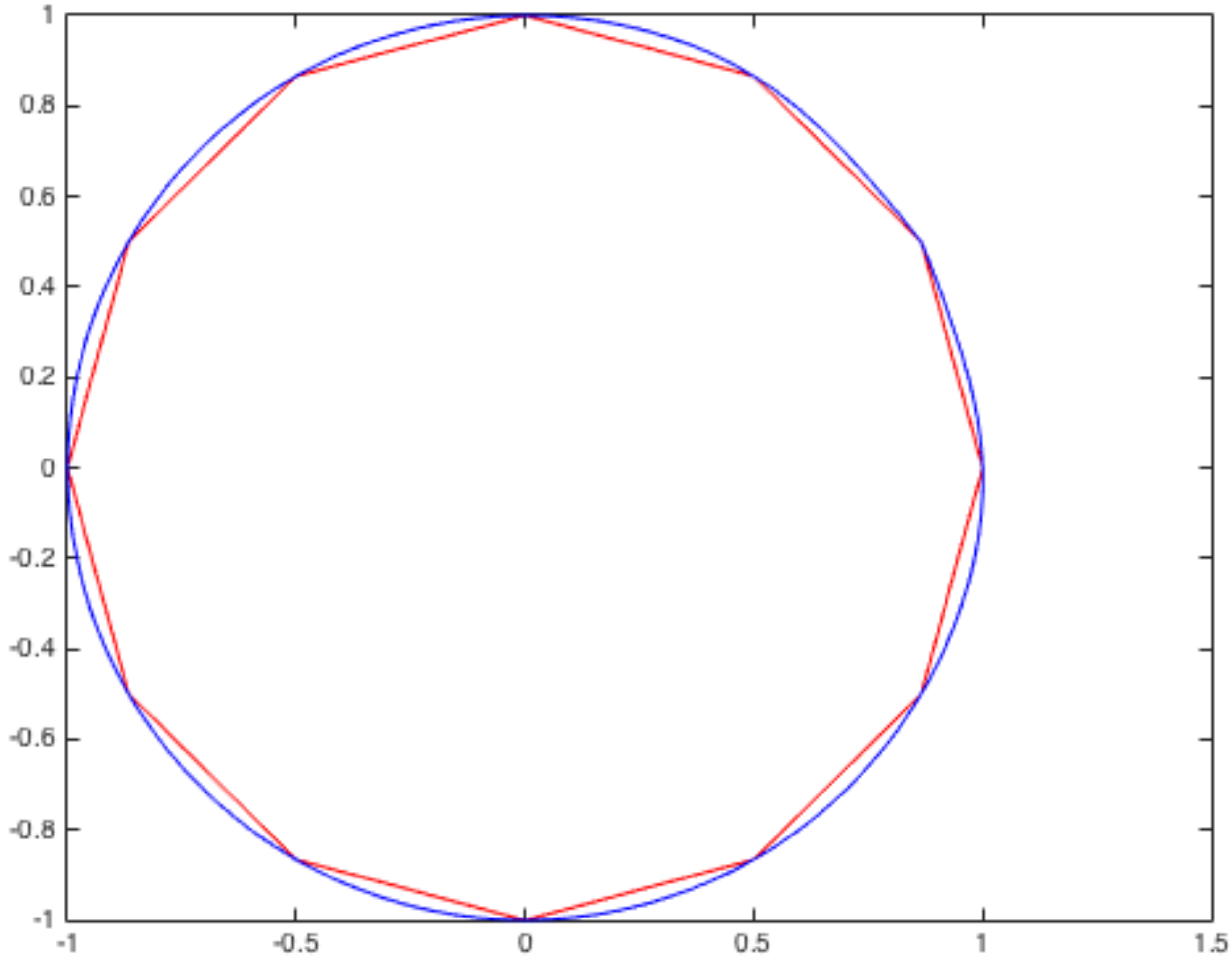


Problem 3

```
% Twelve data points (xi, yi) are given by
%      xi = cos(pi*i/6)
%      yi = sin(pi*i/6)
% These are obviously points on a unit circle with center at (0, 0). To
% close the circle, we get the 13th point whose coord. is identical
% to the 1st coord.
```

a. Use natural splines to fit x and y to parameter p for p values from 1 to 10 in increments of 0.1, and this generate a seq. of (x, y) points for plotting the circle

```
figure

i = linspace(1, 13, 13);
x = cos((pi*i)/6);
y = sin((pi*i)/6);

[a_x, b_x, c_x, d_x] = natural_cubic_spline(i, x);
[a_y, b_y, c_y, d_y] = natural_cubic_spline(i, y);

% evenly spaced 121 intervals
intervals = linspace(1.0, 13.0, 121);

for j=1:121
    q = 1;
    for k=1:13
        if intervals(j) > i(q+1)
            q = k;
        end
    end
    t = intervals(j);
    nth_f = i(q);
    xx(j) = a_x(nth_f) + b_x(nth_f)*(t - nth_f) + c_x(nth_f)*(t - nth_f)^2 + d_x(nth_f)*(t - n
th_f)^3;
    yy(j) = a_y(nth_f) + b_y(nth_f)*(t - nth_f) + c_y(nth_f)*(t - nth_f)^2 + d_y(nth_f)*(t - n
th_f)^3;
end

plot(x, y, 'r', xx, yy, 'b')
```



b. Use a periodicity property of functions cos and sin to generate a periodic spline. compare this spline to natural spline in a) and to the unit circle.

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