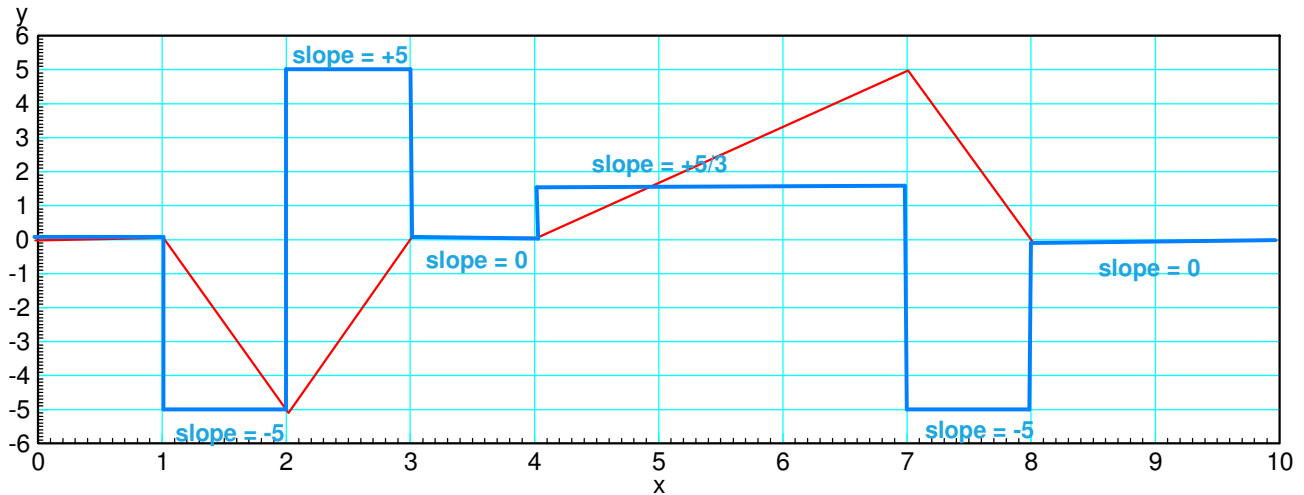


ECE 111 - Homework #4:

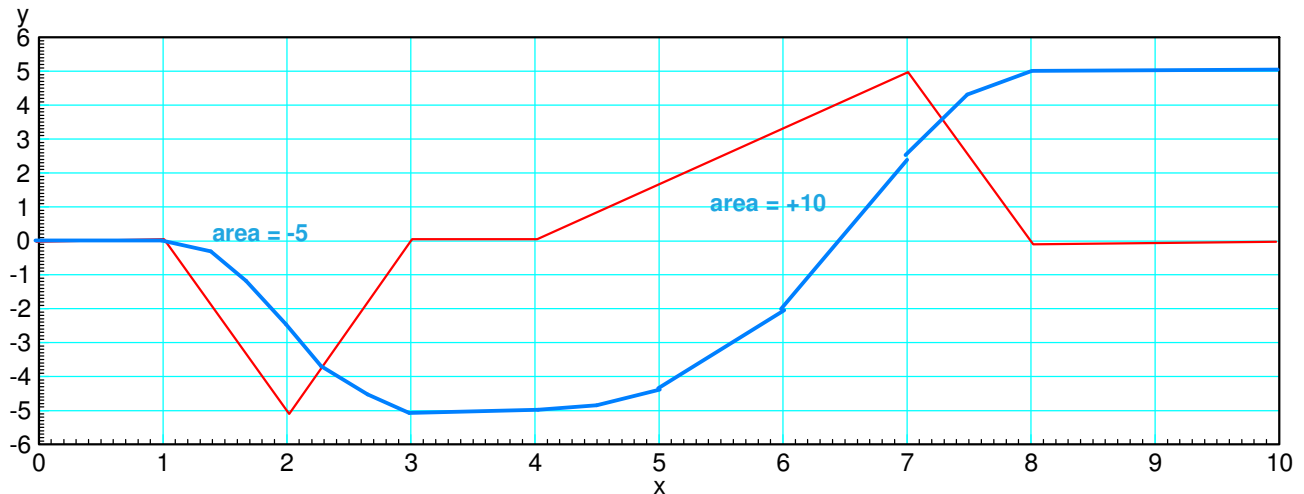
Week #4: Math 165 Calculus

1) Sketch the derivative of the following function

If this is the balance of your checking account, how much money are you adding (positive) or withdrawing (negative) for the balance to be as shown?



2) Sketch the integral of the following function



If this is how much money you are depositing (positive) or withdrawing (negative) from your checking account, what is the balance at each instance?

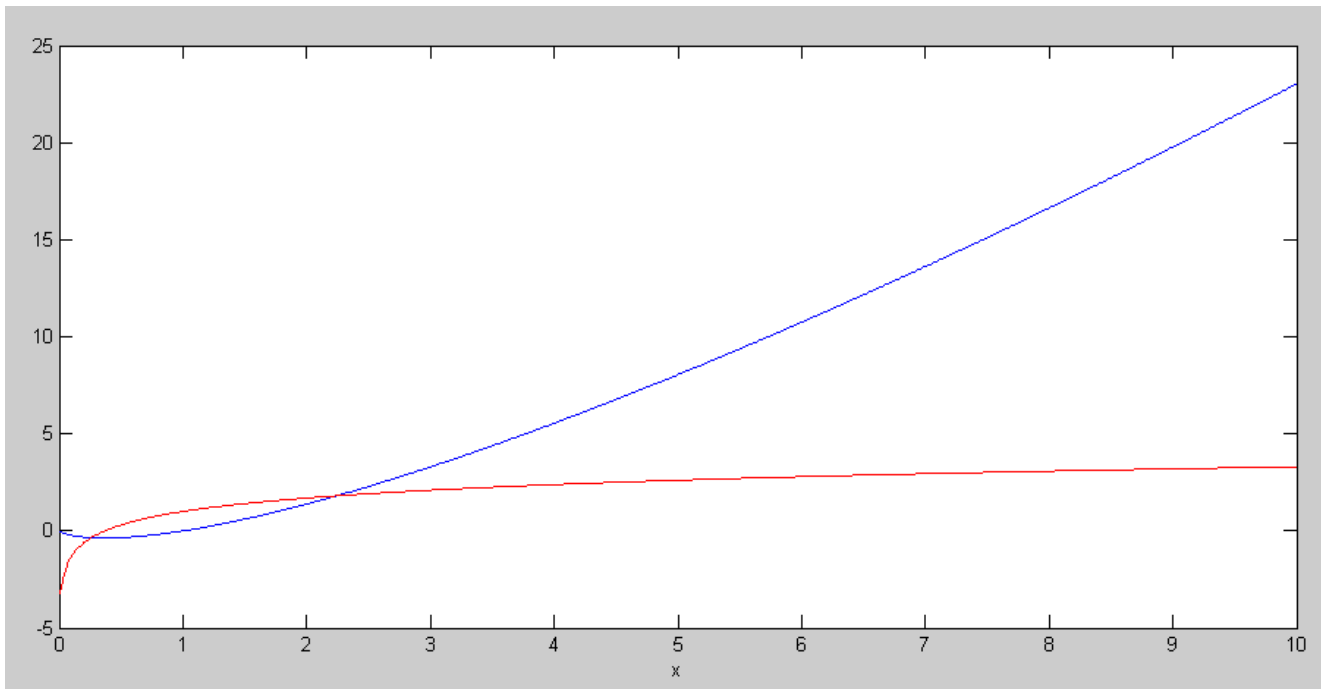
Numerical Differentiation:

3) Use numerical methods to determine the derivative of $y(x)$

$$y = x \cdot \ln(x)$$

for $0.01 < x < 10$. (a plot of $y(x)$ is sufficient).

```
x = [0.01:0.01:10]';  
y = x .* log(x);  
plot(x,y,'b',x,Derivative(x,y),'r');  
xlabel('x');
```



y (blue) and dy/dx (red)

note: The derivative is the slope

- When $y(x)$ (blue line) goes down, the derivative (red line) is negative
- When $y(x)$ goes up, the derivative is positive
- With numerical differentiation, if you can get the function into Matlab, you can find the derivative

4) Use numerical methods to determine the derivative of $y(x)$

$$y(x) = \frac{\sin(x)}{x}$$

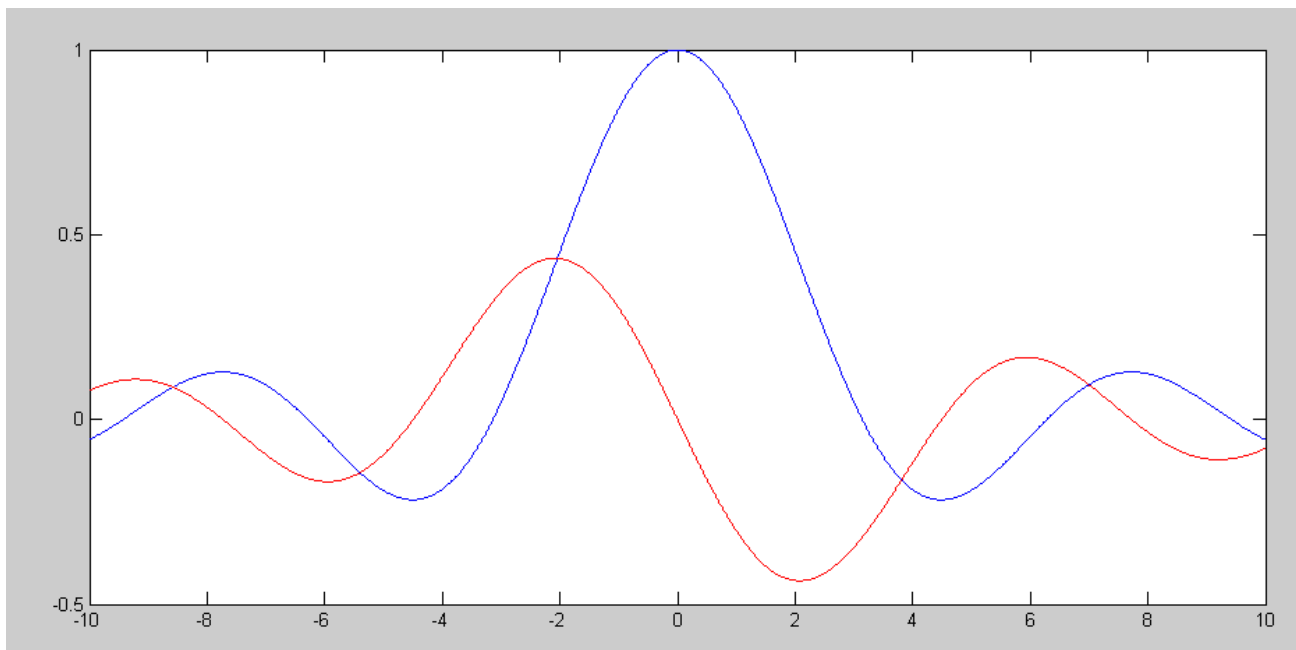
for $-10 < x < 10$. (a plot of $y(t)$ is sufficient).

```
>> x = [-10:0.01:10]' + 1e-6;  
>> y = sin(x) ./ x;  
>> plot(x,y,'b',x,Derivative(x,y),'r');
```

npt =

2001

```
>> xlim([-10,10]);
```



y (blue) and dy/dx (red)

notes:

- x is offset by $1e-6$ to avoid $0/0$ at $x=0$
- When $y(x)$ (blue line) goes down, the derivative (red line) is negative
- When $y(x)$ goes up, the derivative is positive
- With numerical differentiation, if you can get the function into Matlab, you can find the derivative

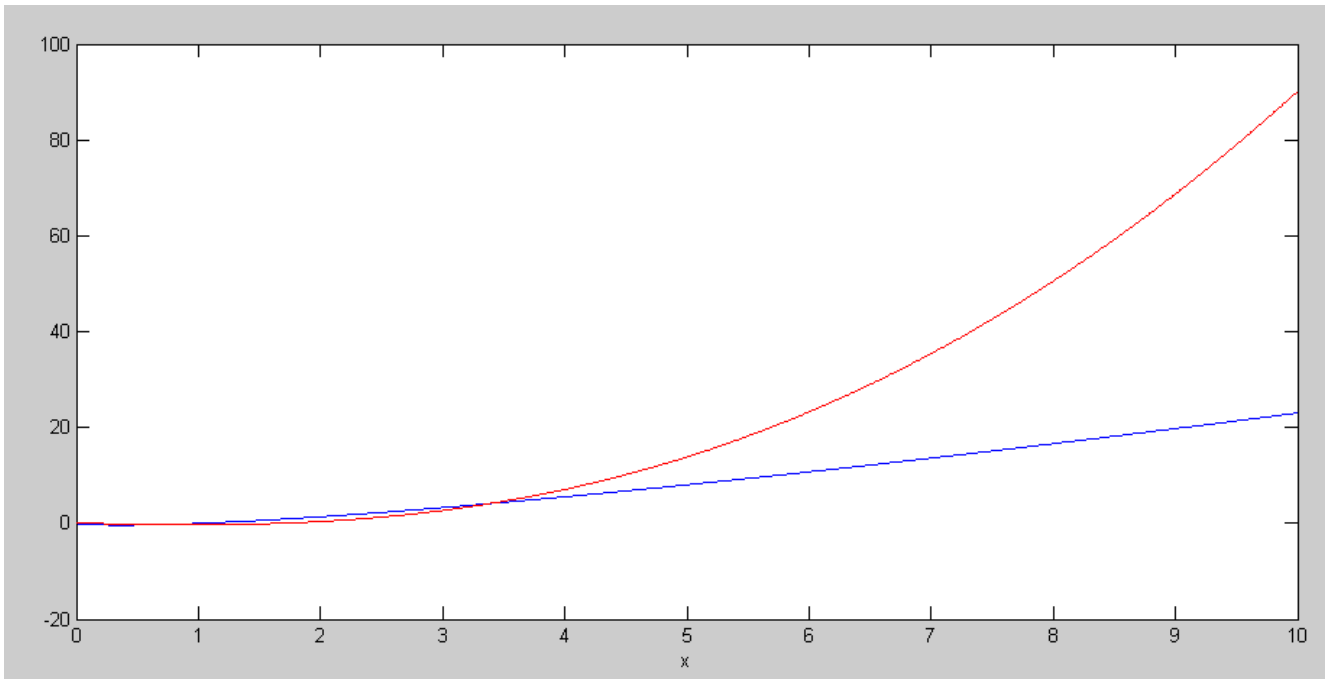
Numerical Integration

5) Use numerical methods to determine the integral of $y(x)$

$$y(x) = x \cdot \ln(x)$$

for $0.01 < x < 10$. (a plot of $y(t)$ is sufficient). Assume $y(1) = 0$.

```
>> x = [0.01:0.01:10]';  
>> y = x .* log(x);  
>> plot(x,y,'b',x,Integrate(x,y),'r');  
>> xlabel('x');
```



$y(x)$ (blue) and the integral of $y(x)$ (red)

notes:

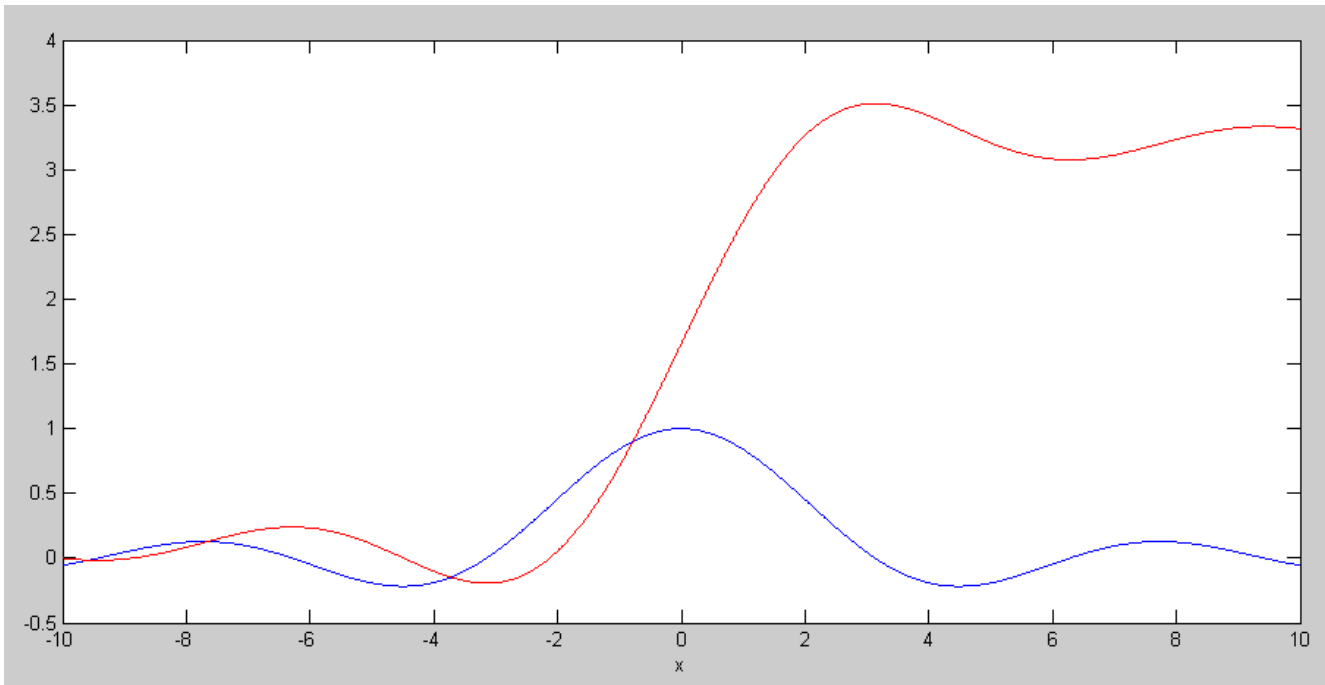
- The integral is the area under the curve
- When $y(x)$ (blue line) is negative, the integral goes down
- When $y(x)$ (blue line) is positive, the integral goes up
- With numerical integration, if you can get the function into Matlab, you can find the integral
- The total area under the curve is the final value of the red line

6) Use numerical methods to determine the integral of $y(x)$

$$y(x) = \frac{\sin(x)}{x}$$

for $0.01 < x < 10$. (a plot of $y(t)$ is sufficient). Assume $y(0.01) = 0$.

```
>> x = [-10:0.01:10]' + 1e-6;  
>> y = sin(x) ./ x;  
>> plot(x,y,'b',x,Integrate(x,y),'r');  
>> xlabel('x');  
>> xlim([-10,10]);
```



$y(x)$ (blue) and the integral of $y(x)$ (red)

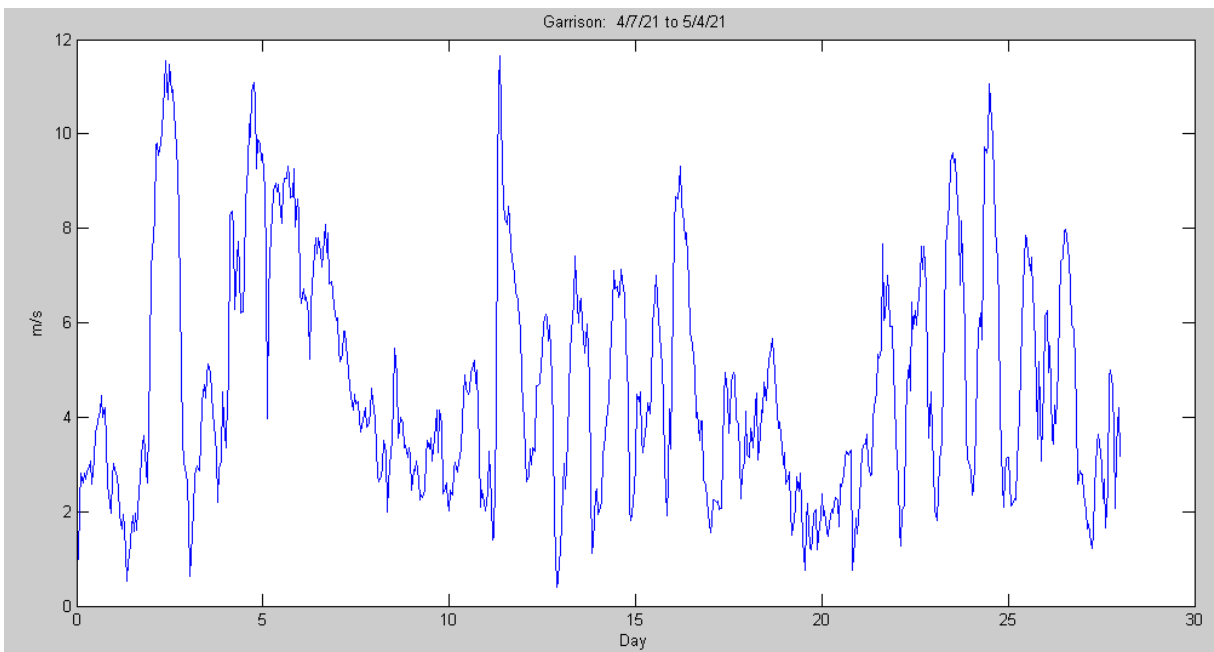
notes:

- The integral is the area under the curve
- When $y(x)$ (blue line) is negative, the integral goes down
- When $y(x)$ (blue line) is positive, the integral goes up
- With numerical integration, if you can get the function into Matlab, you can find the integral
- The total area under the curve is the final value of the red line

Wind Energy

7) Load the last 2-weeks worth of wind-speed data from NDAWN. (close to your home town if you're from North Dakota). Plot this in MATLAB as wind speed vs hour.

<https://ndawn.ndsu.nodak.edu/>



8) Write a function in Matlab where you pass the wind speed at 116m (about 2.2x the wind speed at the ground) and it returns the power generated by a Vestas V117-3.3

Wind Speed (m/s)	0.3	4	5	6	7	8	9	10	11	12	13+
kW	0	147	327	597	978	1,482	2,114	2,803	3,216	3,297	3,300

<https://en.wind-turbine-models.com/turbines/694-vestas-v117-3.3>

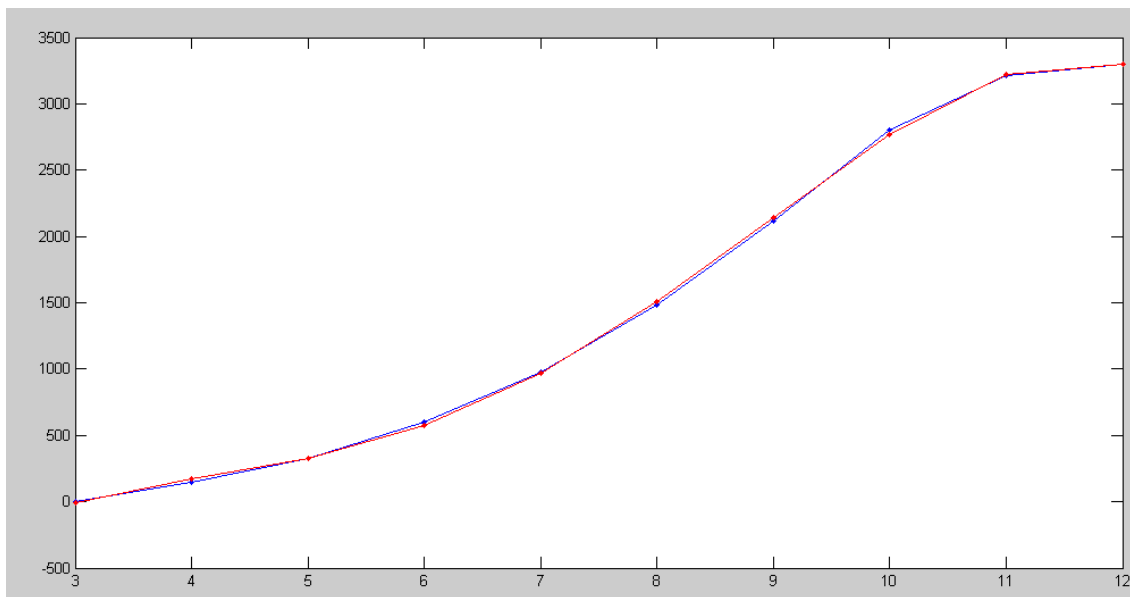
Do a cubic curve fit for the data from 4 .. 12

```
>> B = [x.^4, x.^3, x.^2, x, x.^0];  
>> A = inv(B'*B)*B'*y
```

A =

```
1.0e+003 *  
  
-0.002248980186470  
0.058878302252899  
-0.499153409087857  
1.888304390039746  
-2.589621212096077
```

```
>> plot(x,y,'b.-',x,B*A,'r.-')
```



8a) Determine a function in Matlab to approximate this curve.

```
function [ kW ] = Vesta( wind )

npt = length(wind);
kW = 0*wind;

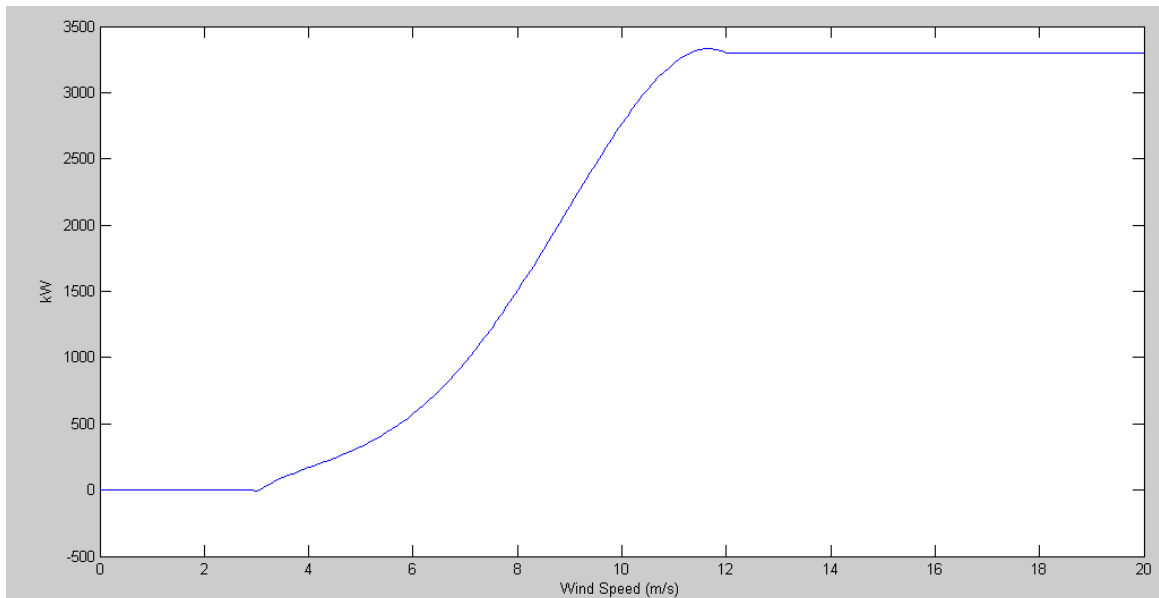
A = [ -0.012647306397336;
      0.316337301588028;
      -2.036959114964928;
      4.102493506506824
      ] * 1000;

for i=1:npt
    x = wind(i);
    if(x < 3)
        y = 0;
    elseif(x < 13)
        y = [x^3, x^2, x, 1]*A;
    else
        y = 3300;
    end

    kW(i) = y;
end
```

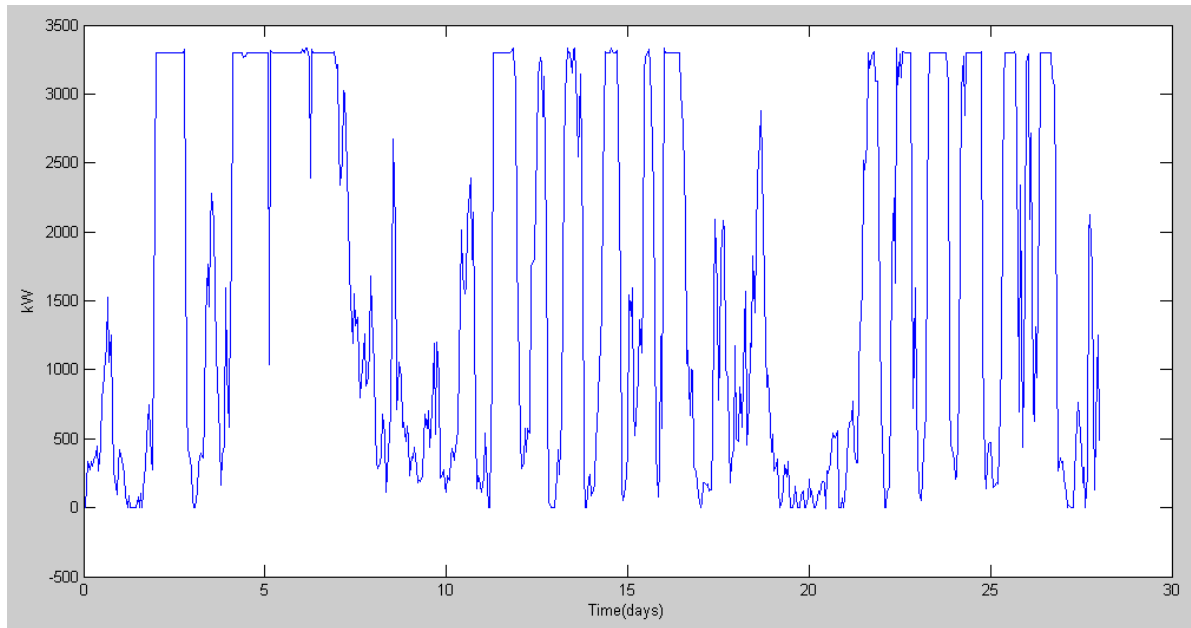
Checking

```
>> x = [0:0.1:20]';
>> plot(x,Vesta(x))
>> plot(x,Vesta(x))
>> xlabel('Wind Speed (m/s)');
>> ylabel('kW');
```



8b) Use this function to compute how much power a Vestas V117-3.3 wind turbine would produce from the wind data your found in problem 3.

```
>> plot(Wind)
>> kW = Vesta(Wind * 2.2);
>> plot(hr/24, kW)
>> xlabel('Wind Speed (m/s)');
>> xlabel('Time(days)');
>> ylabel('kW');
```



9. It takes 1.6 pounds of North Dakota lignite coal to produce 1kWh of electricity. How many pounds of coal is this two weeks equivalent to?

```
>> kWh = sum(kW)
```

```
kWh =
```

```
1.0527e+006
```

```
>> Coal = 1.6*kWh
```

```
Coal =
```

```
1.6843e+006
```

It would take 1.68 million pounds of coal to produce as much energy as the wind turbine produces in 4 weeks.

10. Assume

- This wind turbine costs \$3.3 million to build, and
- You get \$0.11 / kWh for the energy you produce.

How long will it take for this wind turbine to pay for itself at this rate?

```
>> Dollars = kWh * 0.11
```

```
Dollars = 1.1579e+005
```

This wind turbine produces \$115,790 every 4 weeks

```
>> weeks = 3.3e6 / (Dollars/4)
```

```
weeks = 113.9957
```

It takes 113 weeks to produce \$3.3 million worth of electricity

```
>> years = weeks / 52
```

```
years = 2.1922
```

It takes 2.19 years to produce \$3.3 million worth of electricity



<https://en.wind-turbine-models.com/turbines/694-vestas-v117-3.3>