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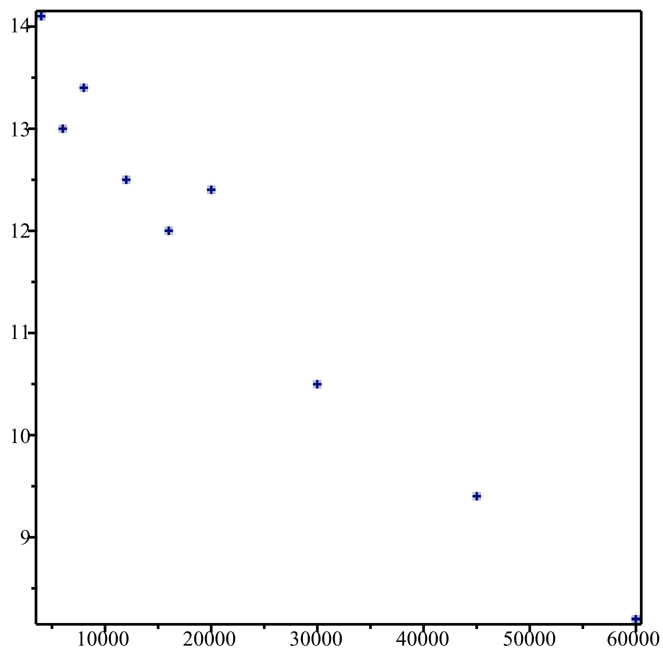
Math 1P01 - Lab #04
Assingment #01 - Maple

Question 15:
a) The table shows (lifetime) peptic ulcer rates (per 100 population) for various family incomes as reported by the National Health Interview Survey. A table is given as Income vs Ulcer rate (per 100 population).

```
> with(Statistics):
> Income:=<4000,6000,8000,12000,16000,20000,30000,45000,60000>:
> Cases:=<14.1,13.0,13.4,12.5,12.0,12.4,10.5,9.4,8.2>:
> ScPlot:=ScatterPlot(Income,Cases);
```



b) Find a linear model using the first and last data points. (Round your values to six decimal places.)
For a linear model, we have:
y = m*x + b, where m=(y1-y0)/(x1-x0)
Considering the first and last points, we have:

```
> m:= (8.2-14.1)/(60000-4000);
```

$$m := -0.0001053571429 \quad (1)$$

Using any data point, let's do both (first and last), we have b= y - m.x :

```
> b:= 14.1-m*4000;
```

$$b := 14.52142857 \quad (2)$$

```
> b:= 8.2-m*60000;
```

$$b := 14.52142857 \quad (3)$$

Now that values of "m" and "b" are known, the linear model (M) is presented as follows :

```
> FLast:= m*x+b;
```

$$FLast := -0.0001053571429\, x + 14.52142857 \quad (4)$$

This linear model intercepts x-axis for y=0, or for x=-b/m:

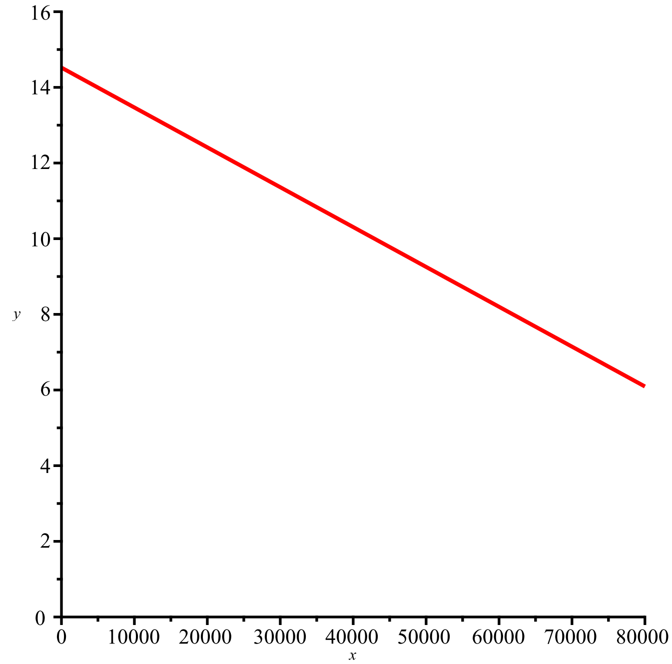
This is a notable point, since the number of cases becomes negative after x_0, losing its meaning for our model.
The same applies for x < 0, where an negative income has no practical meaning.

```
> x_0:= (-b/m); #where y=0
```

$$x\_0 := 137830.5084 \quad (5)$$

Although, x_0 is barely 140,000, let's cap it at 80,000 for better zoom purposes:

```
> FirstLast:= plot(FLast(x), x=0..80000,y=0..16, color=red);
```

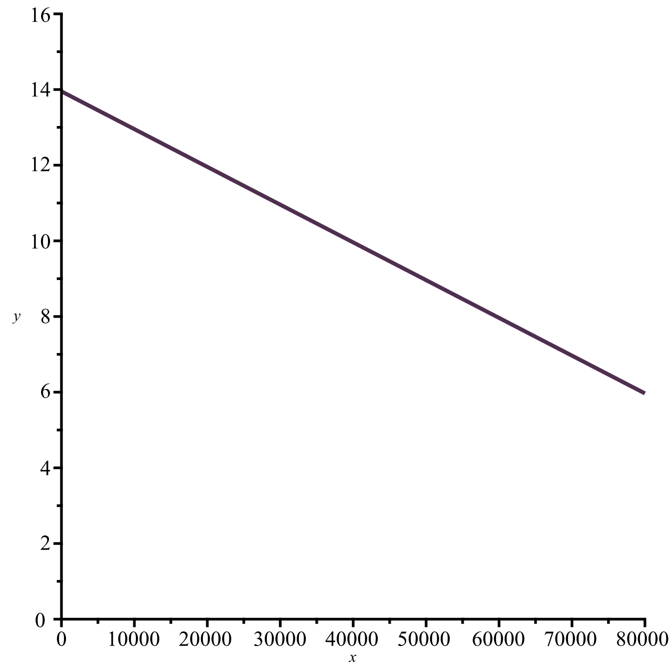


c) Using Maple LinearFit function for the best fit linear model:

```
> LFit:= LinearFit([1,x],Income,Cases,x,summarize=true);
Summary:
----------------
Model: -.99785456e-4*x+13.950764
----------------
Coefficients:
              Estimate   Std. Error  t-value  P(>|t|)
Parameter 1    13.9508    0.2138     65.2621   0.0000
Parameter 2   -0.0001     0.0000    -13.4222   0.0000
----------------
R-squared: 0.9626, Adjusted R-squared: 0.9573
```

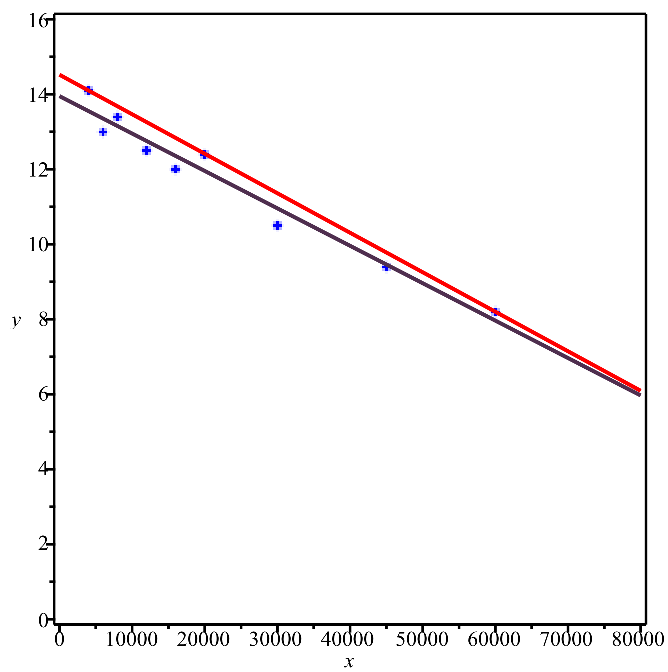
$$LFit := 13.9507640770852 - 0.0000997854561878952\,x \quad (6)$$

```
> BestFit:= plot(LFit(x),x=0..80000,y=0..16, color=violet);
```



Let's plot all of them together, ScatterPlot in Blue, First and Last in Red, and Maple's Best Linerar Fit in Violet.

```
> plots[display]([ScPlot, FirstLast, BestFit], color=[blue, red,
  violet]);
```



d) Use the best fit linear model the Cases for people with an income of $40,000.

```
> subs(x=40000, LFit); #without rounding
```

9.95934582956940 **(7)**

```
> evalf(-0.000100*40000+13.950764); #with rounding
```

9.950764 **(8)**

e) The same for $90,000.

```
> subs(x=90000, LFit); #withouth rounding
```

4.97007302017465 **(9)**

```
> evalf(-0.000100*90000+13.950764); #with rounding
```

$$4.950764 \quad (10)$$

f) Since x_0 <140,000, someone with an income of 200,000 > x_0 would face a negative number of cases, which there's no meaning on this model.

```
> solve(LFit=0); #testing maximum meaningful value of x, which is
  x_0 (y=0)
```

$$139807.5893 \quad (11)$$

```
> subs(x=200000,LFit);
```

$$-6.00632716049385 \quad (12)$$

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Question 27
Graph the given functions on a common screen. Explain how these graphs are related.

Let's define each of the given functions, as follows:

```
> y2:=x->2^x;
```

$$y2 := x \mapsto 2^x \qquad \textbf{(1)}$$

```
> ye:=x->exp(x);
```

$$ye := x \mapsto e^x \qquad \textbf{(2)}$$

```
> y5:=x->5^x;
```

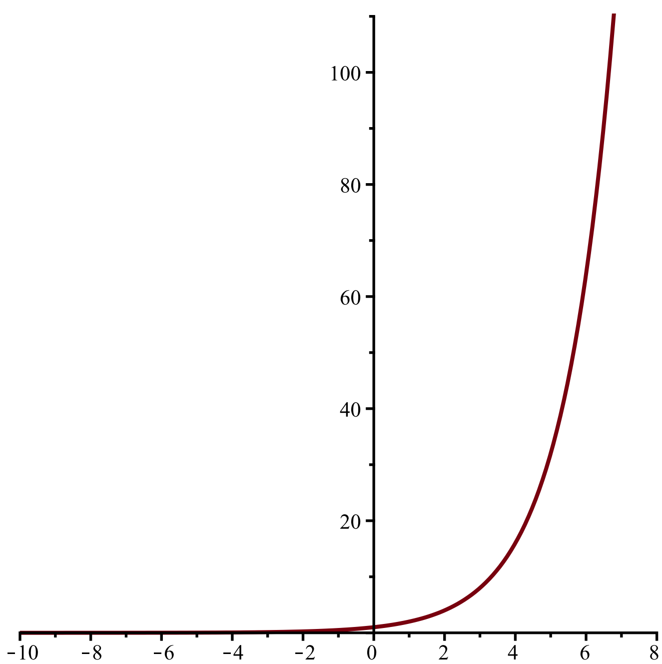
$$y5 := x \mapsto 5^x \qquad \textbf{(3)}$$

```
> y20:=x->20^x;
```

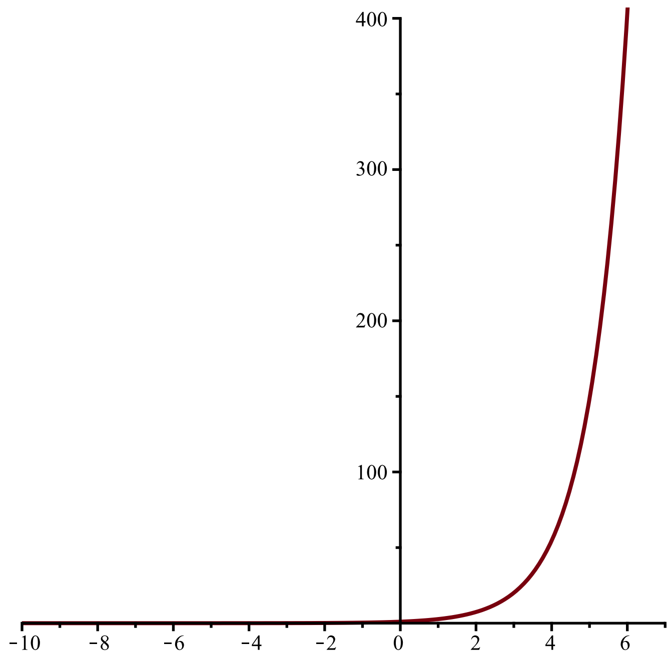
$$y20 := x \mapsto 20^x \qquad \textbf{(4)}$$

Then, let's plot them, one by one:

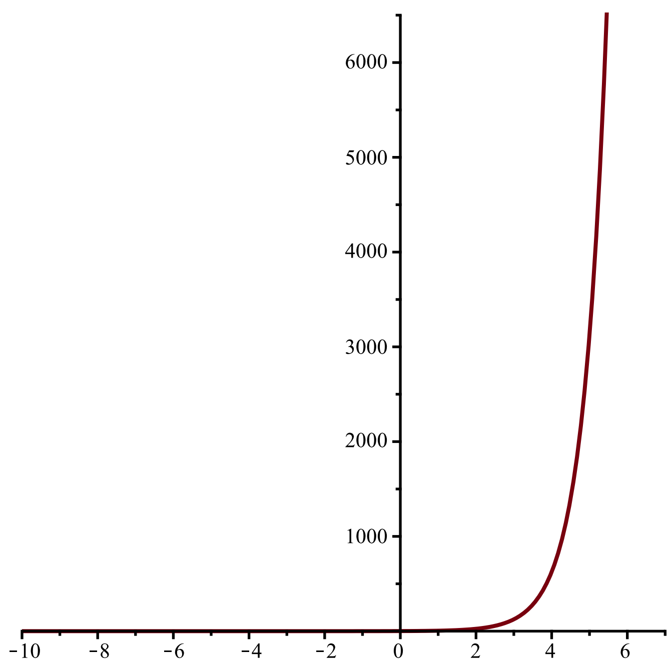
```
> plot(y2);
```



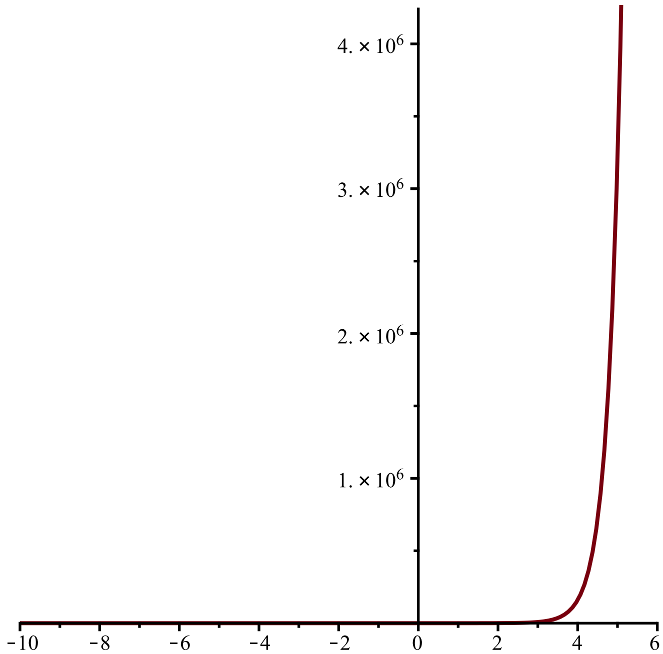

```
> plot(ye);
```




```
> plot(y5);
```

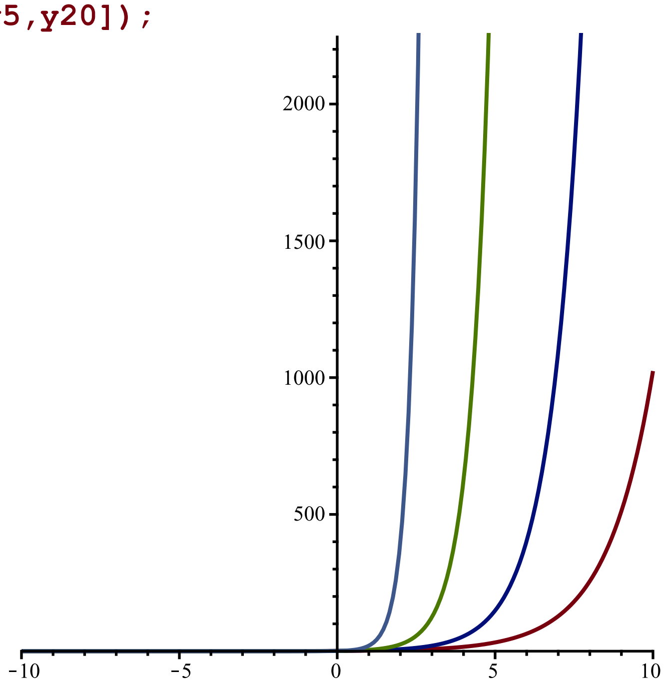



```
> plot(y20);
```



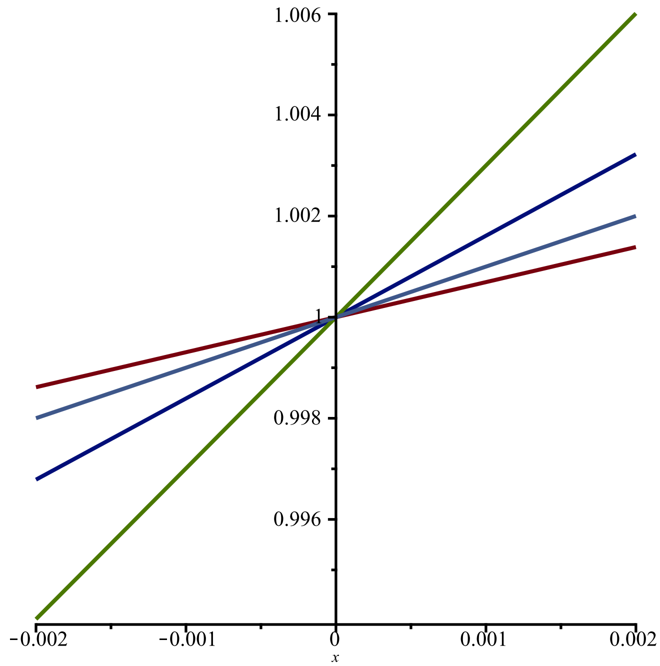
Now, all together:

```
> plot([y2,ye,y5,y20]);
```



Let's plot all of them together with a zoom focused on y-intercept:

```
> with(plots):
> plot({y2(x),ye(x),y5(x),y20(x)},x=-0.002..0.002);
```


1.006
1.004
1.002
1
0.998
0.996
−0.002
−0.001
0
0.001
0.002
x

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Question 36 - Guess the value of the limit (if it exists) by evaluating the function at the given numbers.

Let's create a list of entries for h to be added and subtracted to/from x:

```
> A:=[0.1,0.05,0.01,0.001,0.0001];
```

$$A := [0.1, 0.05, 0.01, 0.001, 0.0001] \quad (1)$$

```
> B:=[-0.1,-0.05,-0.01,-0.001,-0.0001];
```

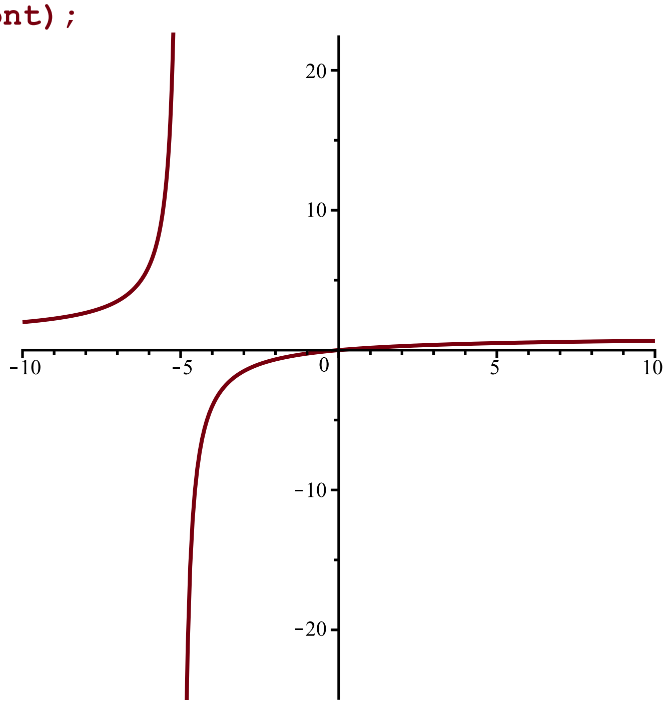
$$B := [-0.1, -0.05, -0.01, -0.001, -0.0001] \quad (2)$$

Let's define the given function as f, where domain D = R-{-5,5}

```
> f:=x->(x^2-5*x)/(x^2-25);
```

$$f := x \mapsto \frac{x^2 - 5\cdot x}{x^2 - 25} \quad (3)$$

```
> plot(f, discont);
```



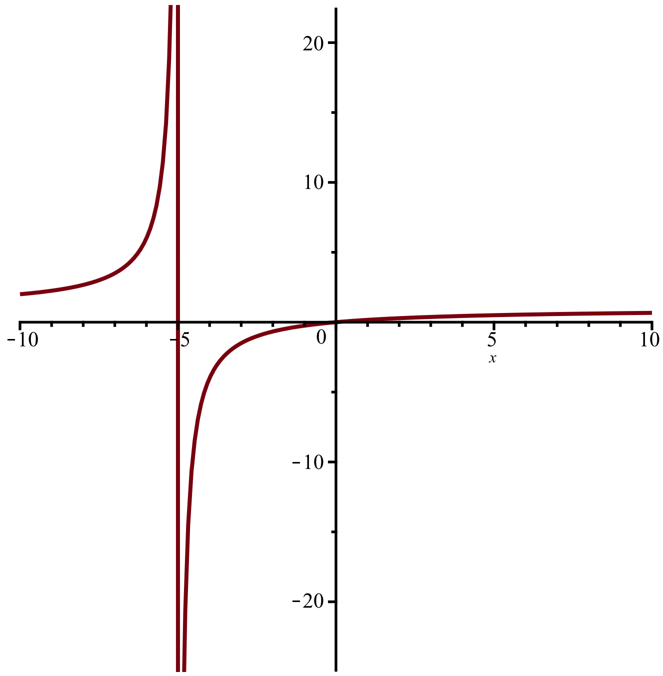
Lets simplify f(x), and atribute its value to another function called s, where x not equal to -5, 5:

```
> s:=simplify(f(x));
```

$$s := \frac{x}{x + 5} \quad (4)$$

Let's verify that they present the same graph scratch:

```
> plot(s);
```



Please note the vertical asymptote x=-5, and f(5) is also not defined (but the empty circle is not marked on the graph).
Now let's substitute the values for (x+h) to answer the question.

```
> f(5.1);
```

$$0.5049504950 \tag{5}$$

```
> f(5.05);
```

$$0.5024875622 \tag{6}$$

```
> f(5.01);
```

$$0.5004995005 \tag{7}$$

```
> f(5.001);
```

$$0.5000499950 \tag{8}$$

```
> f(5.0001);
```

$$0.5000050000 \tag{9}$$

```
> f(4.9);
```

$$0.4949494949 \tag{10}$$

```
> f(4.95);
```

$$0.4974874372 \tag{11}$$

```
> f(4.99);
```

$$0.4994994995 \tag{12}$$

```
> f(4.999);
```

$$0.4999499950 \tag{13}$$

```
> f(4.9999);
```

$$0.4999949999 \tag{14}$$

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Question 46 -The use of the Squeeze Theorem

```
> f:=x->-x^2;
```

$$f := x \mapsto -x^2 \quad (1)$$

```
> g:=x->x^2*cos(17*Pi*x);
```

$$g := x \mapsto x^2 \cdot \cos(17 \cdot \pi \cdot x) \quad (2)$$

```
> h:=x->x^2;
```

$$h := x \mapsto x^2 \quad (3)$$

```
> plot([f,g,h]);
```