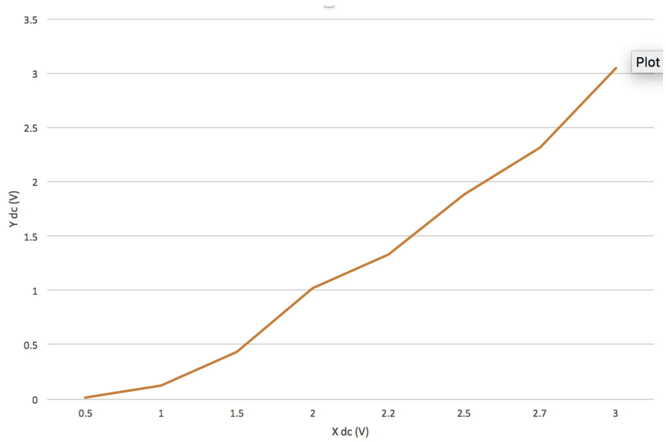
Lab 3

Wednesday, 1 February 2017 09:21

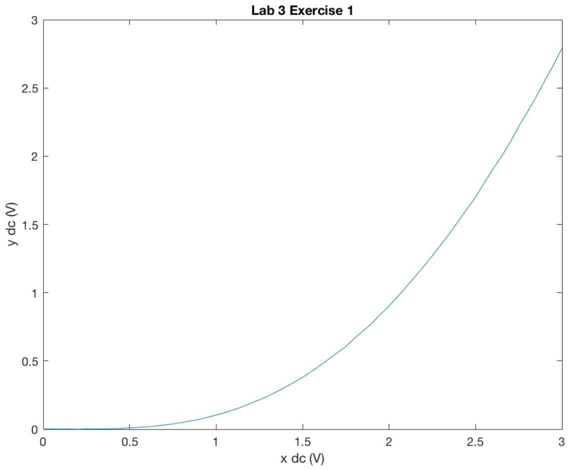
Exercise 1

Measurements for y_dc using set x_dc set out below:

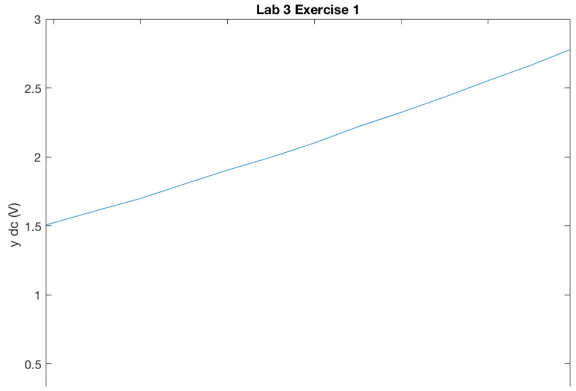
X_dc (V)	Y_dc (V)
3.0	3.0430
2.7	2.3131
2.5	1.8861
2.2	1.3285
2.0	1.0216
1.5	0.4383
1.0	0.1200
0.5	0.0081

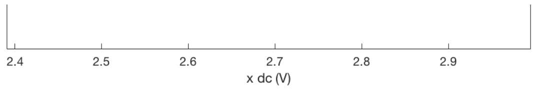


Automatic MATLAB plot seen below for exercise 1.



Shows that the static dc relationship between x and y is non-linear.
If the system was linear the graph should have a constant gradient.
Graph can be seen to be almost linear from approximately 2.4/2.5 volts. See below:





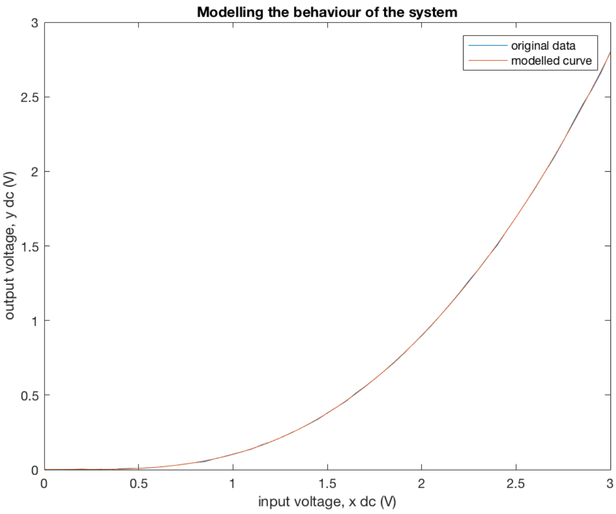
The function can be summarised as $F(x)$. To model this behaviour we need to find the $F^{-1}(x)$. This is because we know:

$$F(x) \times F^{-1}(x) = 1$$

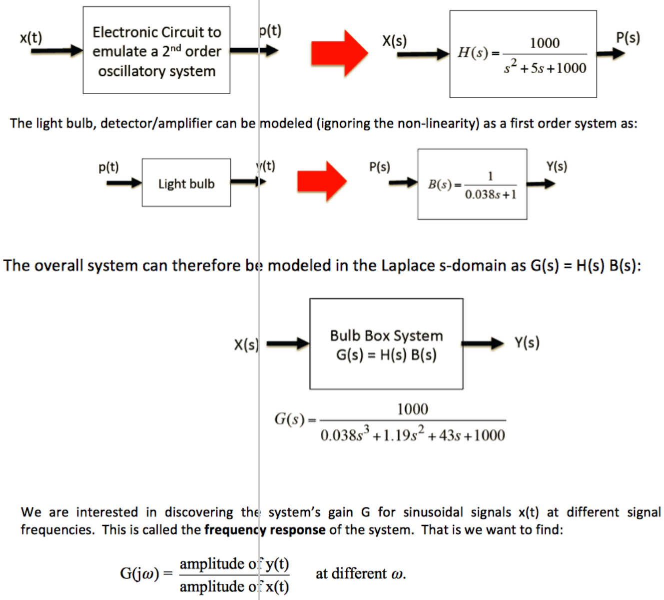
Once we produce the graph of $F^{-1}(x)$ then we can model this linear graph using the standard equation for lines:

$$y = mx + c$$

Alternatively we can use the MATLAB function *polyfit* to characterise the data points we have by trying to fit an n^{th} degree polynomial to our original data points. With experimentation we can use an 8^{th} degree polynomial to achieve sufficient accuracy to model the behaviour of the system.



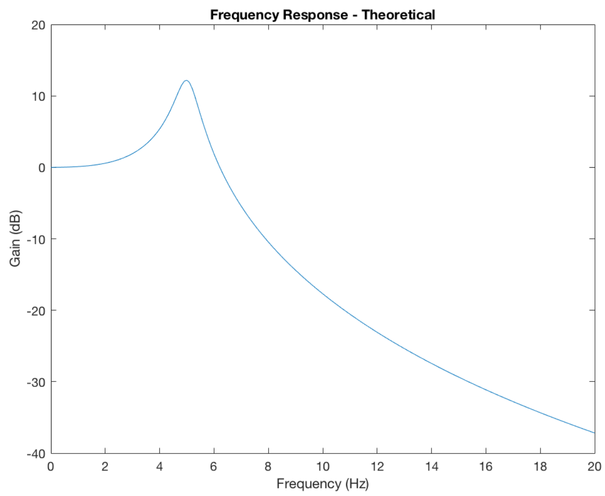
Exercise 2



The frequency response is measured with this equation (in the Laplace domain)

$$G(s) = \frac{1000}{0.038s^3 + 1.19s^2 + 43s + 1000} \text{ where } s = j\omega = j(2\pi f)$$

The theoretical frequency response is therefore



Manually evaluating the $G(s)$ function results in substituting in the values for, 0 and 5 Hz using the equation above and converting G into decibels using $G_{dB} = 20log_{10}(G)$

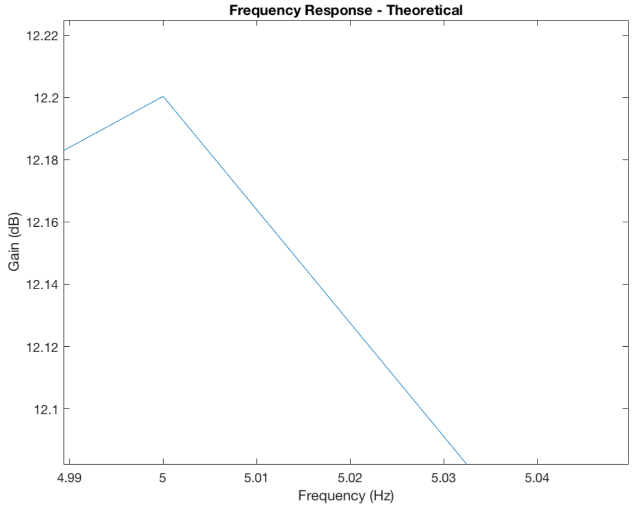
$f_1 = 0\ Hz$ $s_1 = 0$ $G(s_1) = \frac{1000}{0 + 0 + 0 + 1000} = 1$ $G_{dB}(s_1) = 20log_{10}(1) = 0\ dB$	$f_2 = 5\ Hz$ $s_2 = 10\pi j$ [Equation] [Equation] [Equation]

As we can see this matches with what we see on the graph.

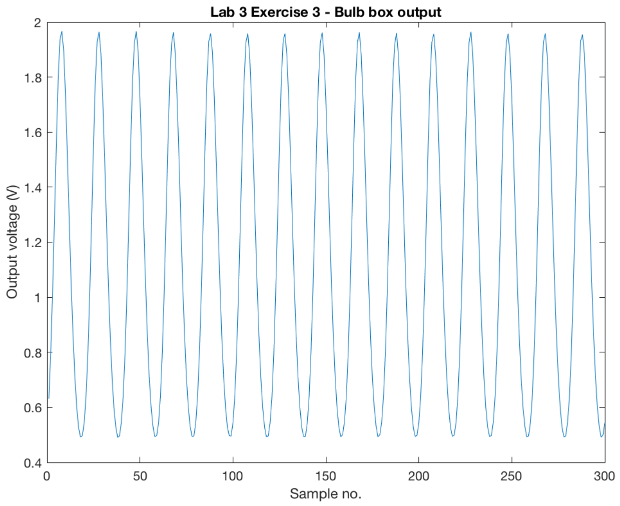
Exercise 3

Setting the signal frequency to 5, we would expect a gain ([Equation] function return) of approximately [Equation]

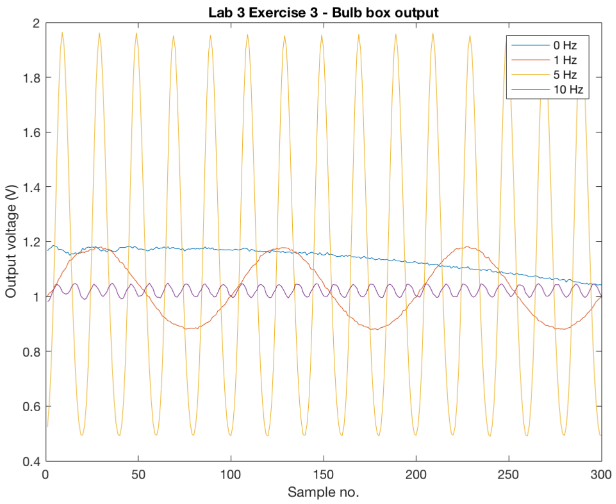
This can be seen in the zoomed in figure of the theoretical frequency response.



However the returned results of G from the third exercise shows that the [Equation]
Our response of the system can be seen below:



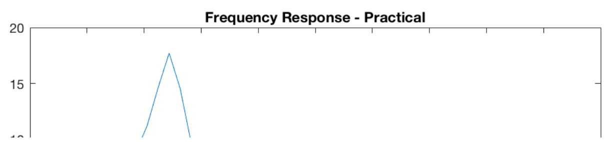
We went back and measured the output voltage again for different frequencies. The response was recorded as seen below:

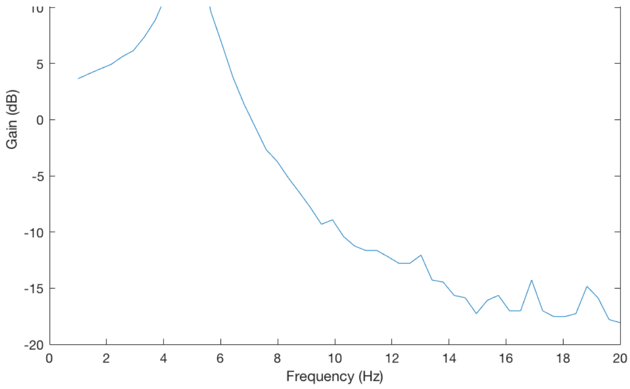


We did not repeat this exercise for a number of frequencies and instead wanted to plot the gain over a large range of frequencies to see a more detailed graph. This was done in the section below, exercise 3a.

Exercise 3a

We wrote the code to plot the frequency against the gain for a range of frequencies from 1 Hz to 20 Hz.





Exercise 4

The step response of the system shows that the voltage oscillates before settling at the target voltage. This occurs on both a step-up and a step-down. The output shows how the system has a slow response to its input. Hence the value overshoots before responding by bringing down to the target output .