**Exercise 1: Nonlinear fitting to noisy data in Matlab**

Data fitting to noisy data with a non-linear function can be problematic, as the fitting routines employ some form of search algorithm to lock in on the function parameters. Observing the parameter and plotting the residuals can give confidence that convergence on the global best parameters has occurred. In many cases, initial guess parameters are required to get a suitable fit, and often one parameter is highly sensitive.

Load the dataset sine\_data.mat into a Matlab workspace (download the file to your Matlab directory and type load sine\_data). The “y” axis data is contained in the variable y, the “x”axis data is contained in x.

What is the frequency of the sinusoid, and its uncertainty?

* Determine the frequency by fitting your data to a sinusoidal function using the Curve Fitting App in Matlab. Note: Make sure you make your sinusoidal function suitably general.
* Use the residuals plot (“View” – “Residuals Plot”) and the parameter to verify that you have found the best fit parameters.

**Exercise 2: Laboratory power supply modes**

Here we will investigate using a power supply in both constant current and constant voltage modes with a variable load (a selectable number of light bulbs). Note that the bulbs can handle the maximum voltage of the power supply (i.e., you can’t kill the bulbs!).

**Constant voltage mode**

**To use the supply in constant voltage mode:**

* Set the **current control** to maximum (turn clockwise fully). Until the maximum current is reached, the power supply will keep the voltage constant at the value set with the voltage control. (Here the maximum supply current is around 5A)
* Connect a bulb across the power supply.
* Adjust the **voltage control** until the current drawn is 0.18 A, and note the voltage.

Investigate adding an additional bulb in **parallel**:

* What do you note about the current now drawn, and the supply voltage?

**Answer:**

**Changing the load changes the current drawn but not the supplied voltage (remained at 12.1).  
Current increased to 0.37A**

* Does the brightness of the original light bulb change when the new bulb is added?

**Answer:**

**Brightness did not change**

Investigate connecting the two bulbs in series:

* How does the supply current change compared to that drawn by a single bulb?

**Answer:**

**The current drawn and brightness decreased to 0.12A when the lightbulbs where connected in series (<half the current drawn for 2 bulbs in parallel. But >half the current drawn for a single bulb)**

* Has the supply voltage changed?

**Answer:**

**No, since the setting is set to constant voltage**

* Is the behaviour of the power supply consistent with the concept of a “constant voltage” source? Why?

**Answer:**

**A change in load is not reflected in a change in voltage given the settings**

* Why is the current drawn when the bulbs are in series not half that for a single bulb?

**Answer:**

**This is dependent on the resistance. If we consider the lightbulbs to be simple resistors (The resistance of a light bulb filament changes with temperature)   
In the case of bulbs connected in series the voltage supplied to each bulb is halved (any current that flows through one bulb must go through the other bulbs as well), therefore there is less resistance in the circuit than the the case of a single bulb connected to the power supply. As we observed, the current drawn by the series circuit is greater than half the current drawn by a single bulb.**

**Constant current mode**

Reconfigure with a single bulb connected to the supply.

**To use the power supply in constant current mode:**

* Turn the **voltage control** to maximum (turn clockwise fully).
* Set the maximum current to 0.18 A using the **current control** (unfortunately touchy for these power supplies). Note that the “current limited” indicator light is illuminated and the voltage indicated is reduced as the current is lowered.
* Note the supply voltage when 0.18 A has been set.

Connect an additional bulb in parallel:

* What do you note about the current now drawn, and the supply voltage?

**Answer:**

**The current has not changed but supply voltage drops to 3.7V**

* Is the brightness of the original light bulb still the same?

**Answer:**

**no, the brightness has dropped drastically**

* Is the “current limited” indicator still on?

**Answer:**

**Yes, since we have not changed the constant current setting**

Connect the two bulbs in series:

* What do you note about the current now drawn, and the supply voltage?

**Answer:**

**The current display remains as 0.18 A**

**The supply voltage increased to 25.4V**

* Is the brightness of the light bulb still the same as the single bulb case?

**Answer:**

**It is close in brightness if not the same brightness.**

* Is the “current limited” indicator still on?

**Answer:**

**Yes, the Current limited LED is still on.**

Short out the power supply by disconnecting **one** of the bulbs from its leads and connecting the leads together.

* What do you note about the current now drawn, and the supply voltage?

**Answer:**

**ht supply voltage has dropped to zero but the current drawn remains at 0.18A**

* Is the “current limited” indicator still on?

**Answer:**

**Yes, since the power supply is still providing current**

* Is the behaviour of the power supply consistent with the concept of a “constant current” source? Why?

**Answer:**

Yes, The current pdrawn is independent of the load on the power supply