Exercise 1: Introduction to fitting methods

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Abstract

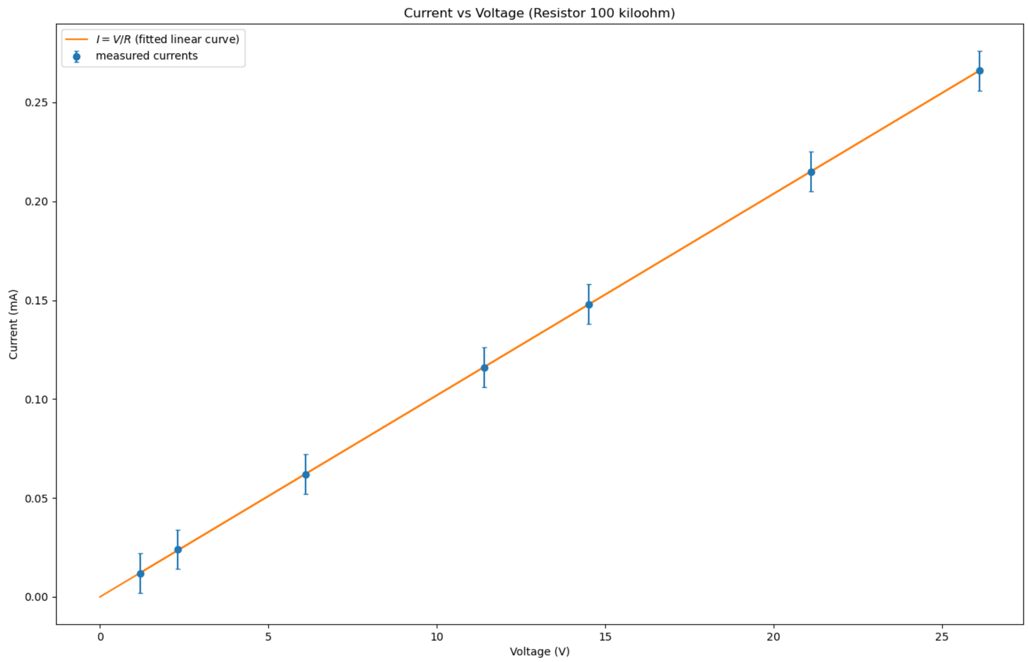
1 Introduction

2 Theory

3 Procedures

Voltage (V)	Current (mA)	Resistance (kOhm)
1.2	0.012	100
2.3	0.024	95.83333333
6.1	0.062	98.38709677
11.4	0.116	98.27586207
14.5	0.148	97.97297297
21.1	0.215	98.13953488
26.1	0.266	98.12030075

4 Analysis



5 Conclusions

6 Appendix

```python
import numpy as np
import scipy.optimize as optim
import matplotlib.pyplot as plt

def chi2(y_measure,y_predict,errors):
    """Calculate the chi squared value given a measurement with errors and
    prediction"""
    return np.sum( np.power(y_measure - y_predict , 2) / np.power(errors , 2) )

def chi2reduced(y_measure, y_predict , errors , number_of_parameters):
    """Calculate the reduced chi squared value given a measurement with errors
    and prediction,
    and knowing the number of parameters in the model."""
    return chi2(y_measure, y_predict , errors)/(y_measure.size -
   number_of_parameters)

# we have constant voltage uncertainity which is 0.1 V
voltage_uncertainity = 0.1

def current_uncertainity(current):
    """return the uncertainity in current for given values of current"""
    if current > 100:
        return 1
    elif current > 10:
        return 0.1
    else:
        return 0.01

#  model function
def compute_current(voltage, resistance):
    """compute the current value for given voltage and resistance"""
    return voltage / resistance

# filename
filename = "100k.csv"

# load the csv file as txt
measured_voltages, measured_currents = np.loadtxt(filename,
                                                  skiprows=1,
                                                  usecols=(0,1),
                                                  delimiter=",",
                                                  unpack=True)

# create error array for the voltage
voltage_errors = np.ones_like(measured_voltages) * voltage_uncertainity

# create error array for the current
current_errors = np.vectorize(current_uncertainity)(measured_currents)

# do the curve fitting
popt, pcov = optim.curve_fit(compute_current,
```

```
                                    measured_voltages,
                                    measured_currents,
                                    absolute_sigma=True,
                                    sigma=current_errors)
pvar = np.diag(pcov)

# new figure for this file
plt.figure(figsize=(16, 10))
plt.style.use("default")

# plot the error bar chart
plt.errorbar(measured_voltages,
             measured_currents,
             yerr=current_errors,
             marker="o",
             label="measured currents",
             capsize=2,
             ls="")

# plot the fitted curve
# add 0 to the measured data set
measured_voltages_with_0 = np.append(measured_voltages, 0)
plt.plot(measured_voltages_with_0,
         compute_current(measured_voltages_with_0, popt[0]),
         label='$I = V/R$ (fitted linear curve)')

# legend and title
plt.title("Current vs Voltage (Resistor 100 kiloohm)")
plt.xlabel("Voltage (V)")
plt.ylabel("Current (mA)")
plt.legend(loc="upper left")
plt.savefig("lab_1_ex_1_plot.png")

chi2r = chi2reduced(measured_currents,
                    compute_current(measured_voltages, popt[0]),
                    current_errors,
                    1)

print("model chi2r = %.3f" % chi2r)
print("fitted (average) resistance = %.3f kiloohm" % popt[0])
print("error in fitted resistance = %.3f kiloohm" % np.sqrt(pvar[0]))
```

References

[1]