CCE2301—MATLAB: Practical 2

Trevor Spiteri
trevor.spiteri@um.edu.mt
http://staff.um.edu.mt/trevor.spiteri

Department of Communications and Computer Engineering
Faculty of Information and Communications
University of Malta

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Plotting in MATLAB

Objective

The objective of this practical is to use the MATLAB plotting features.

1 Procedure

An electric circuit is connected to a DC source. The voltage across two points is measured every second. The readings are given in Table 1.

1. Create two vectors containing the data, `t` for the time and `v` for the voltages. `t` and `v` should have 11 elements each. Draw a plot of voltage against time. Use a solid line with circle markers.

2. The next task is to write a mathematical function which models the readings. First, look at the plot and see if you are familiar with this kind of

Table 1: Voltage readings

Time (s)	0	1	2	3	4	5	6	7	8	9	10
Voltage (V)	0.0	2.6	3.8	4.5	4.8	5.0	5.0	5.1	5.0	5.1	5.1

Table 2: Functions that can be plotted as stright lines

Kind of function	Form	Straight-line plot
Linear	$y(x) = mx + b$	`plot(x, y)`
Power	$y(x) = bx^m$	`loglog(x, y)`
Exponential	$y(x) = be^{mx}$	`semilogy(x, y)`
Logarithmic	$y(x) = m\ln(x) + b$	`semilogx(x, y)`

curve. Then, try to see if the function is one of those listed in Table 2. **Hint:** You may need to transform the function. Try the transformation:

```
>> vt = n - v;
```

Deduce a number `n` from the data.

3. Confirm that your new data `vt` will give a straight line when it is plotted against `t` using the required command from Table 2.

4. Use `polyfit` to find the coefficients b and m of the function you are discovering. **Hint:** You may need to omit some values from the end of your vectors `t` and `vt`.

5. Once you have deduced a mathematical function for `vt`, write down a mathematical function for `v`. Remember that `vt` = `n` − `v`.

6. On one set of axis:

   (a) Plot the measured data `v` against `t`, using no lines and plus (+) markers.

   (b) Plot the function you have discovered for the time range 0 s–10 s, using a solid line and no markers.

7. Using your discovered function, try to obtain a value for the voltage at the following times by interpolation: 0.5 s, 1.5 s, 6.5 s, 9.5 s.

8. Using your discovered function, try to obtain a value for the voltage at the following times by extrapolation: −5 s, −0.5 s, 20 s, 40 s. Comment on the validity of these values.

An electric network has the following transfer function:

$$TF = \frac{v_o}{v_i} = \frac{RCs}{RCs + 1}$$

where *TF* is the transfer function,

v_o is the output voltage in V,
v_i is the input voltage in V,
R is the resistance, 200 Ω,
C is the capacitance, 100 μF,
s is $j\omega$,
ω is the frequency in rad/s.

You are required to plot this transfer function for $1 \leq \omega \leq 1000$.

9. Generate a vector `omega` which contains the values for ω. To do this, use the `logspace` function. Note that `omega` is required to be between 10^0 and 10^4. For more help, type:
`>> doc logspace`

10. Generate a vector `tf` which contains the transfer function *TF* for each corresponding value of `omega`. The lengths of the `tf` and `omega` vectors must be the same.

11. Split the figure window into two subplots (two rows, one column) using the `subplot` command. In the first subplot, plot the magnitude of *TF* against ω using a log-log scale. In the second subplot, plot the phase shift (the angle) of *TF* against ω using a log scale for ω and a linear scale for the phase shift.

Another electric circuit gives oscillations according to the system equation

$$v = (1 - e^{-t/\tau})\cos(2.6t + 0.13)$$

where v is the voltage in V,

t is the time in s,
τ is the time constant in s.

12. The time constant τ can be varied in the range $0.5 \leq \tau \leq 10$. Obtain a mesh of the voltage v against the time constant τ and the time t to help you visualize how the voltage depends on the time constant. Write down what you observe from the plot.

Report

Your report should include any MATLAB scripts and functions that you wrote, the results, the plots, and any observations and comments. You do not need to print 3-D plots. Note that printed plots should be labelled properly.