Lab One
Computational Physics
Kigali Institute of Science and Technology

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The purpose of this lab is for you to gain some initial experience with matlab. The best way to learn matlab is to try it out and experiment. If you get stuck, try using the web to search for help, ask another lab group, or ask me for help.

I don't know how far we will be able to get today. And I don't know how the computers will work in the lab. Thanks you for your patience.

There is nothing to hand in from today's lab. The goal is to explore and experiment.

Using Matlab as a Calculator. From the matlab prompt, try typing the following

1. `3+4`
2. `3*4`
3. `a = 4`
4. `a^3`
5. `cos(0)`
6. `sin(pi)`
7. `exp(1)`

Use Matlab to determine the value of the following quantities:

1. $\log(4)$
2. $e^{-\frac{1}{3}}$
3. $\sin(1)$
4. π^3

Simple Plotting: The plot command is of the form `plot(xdata, ydata)`. The `xdata` needs to be in the form of a list. Try the following commands to see different ways matlab can make lists:

1. `x = 0:0.2:1`
2. `x = 0:0.1:pi`
3. `x = -pi:0.01:pi;`

Note the semi-colon ";" in the last line above. A semi-colon tells matlab to not print the output.

The following commands will make a plot of a sine function

```
x = 0:0.5:2*pi
y = sin(x)
plot(x,y)
```

The plot does not look very smooth. Make it smoother by increasing the number of points in `x`.

You can label axes for a plot as follows.

```
t = 0:0.01:10;
N = 4*exp(-0.5*t);
plot(t,N)
xlabel('time in hours')
ylabel('number of atoms')
title('radioactive decay')
```

Multiple plots on the same axes: Often we want to plot two functions on the same axes so we can compare them. Here is an example of how to do this:

```
x = 0:0.01:2*pi;
y1 = sin(x)
y2 = cos(x)
plot(x,y1,x,y2)
```

Try plotting the functions e^{-x} and e^{-2x} on the same axes.

Sine wave exploration: Let

$$S_1 = \sin(\frac{t}{1.00\pi}) \tag{1}$$

$$S_2 = \sin(\frac{t}{1.01\pi}) \tag{2}$$

$$T = S_1 + S_2 \ . \tag{3}$$

Plot T. Experiment with different ranges for t so you can appreciate T's behavior. What do you observe? What does it mean physically?

Some exercises we will do in the event that we can't get into the computer lab today:

1. Consider the function $g(x) = \frac{1}{2}x^2 - 32$
   (a) Sketch the function $g(x)$, and use algebra to find the largest root of $g(x)$
   (b) By hand, carry out the first three steps in the bisection method to find the largest root of $g(x)$. Start with the interval $[0, 10]$.
   (c) By hand, carry out the first three steps in the Newton's method to find the largest root of $g(x)$. Start with $x_0 = 1$.
   (d) By hand, carry out the first three steps in the Newton's method to find the largest root of $g(x)$. Start with $x_0 = 100$.
2. Find the first three non-zero terms in the Taylor expansion of $\sin(x)$ about $x = 0$.
3. Find the first three non-zero terms in the Taylor expansion of $\ln(x)$ about $x = 2$.