# Lab Four
# Computational Physics
# Kigali Institute of Science and Technology

**Finish Exercises from Last Time.** Do these exercises and **turn in your answers at the end of the lab session**. You may work in groups of two or three if you want. For all of these problems, keep the width fixed at $a = 0.3$ nm. For each question, include a short explanation of how you solved the problem.

1. First, set $V_0 = 100000$. This corresponds to an approximately infinite well. Make plots of `even(E)` and `odd(E)` and find the approximate location of the lowest solution. Then use the `fzero` command to find a more exact answer for the lowest energy level. Is your answer what you would expect? Explain briefly.
2. Determine all allowed energies if $V_0 = 20$. (Remember that our equations do not hold if $E > V_0$.)
3. For what approximate range of $V_0$ are there exactly three bound states?

**Euler's Method.** I have prepared a short matlab function that will calculate and make plots of approximate solutions to differential equations obtained via Euler's method. To see how to use this code, do the following:

1. Find the file `euler.m` from `http://hornacek.coa.edu/dave/KIST`. Copy this code into a file on your computer. The file must have the name `euler.m`.
2. Read over the matlab code you just downloaded. The comments in the code should explain what the function does and how to use it.
3. The `euler` function finds approximate solutions to differential equations of the following form:

   $$y'(t) = f(y,t) \ . \tag{1}$$

   You will need to define the function $f(y,t)$. Do so with the `inline` command. For example, to solve the equation we discussed in class and that is in the notes from class four, type

   ```
   f = inline('-t*y', 't', 'y')
   ```

4. You also need to tell matlab the initial and final values for $t$, the initial condition for $y(t)$, and the number of steps. Doing so then determines the step size $\Delta t$. If the initial $t$ value is $a$ and the final value is $b$, then

   $$\Delta t = \frac{b-a}{n} \ . \tag{2}$$

   For the example from class, $b = 2$, $a = 0$, $y(0) = 2$ and $n = 8$. To get the Euler solution, type the following:

   ```
   euler(f, [0,2], 2, 8)
   ```

   The general command is

   ```
   euler(f, [initial_t,final_t], initial_condition, number_of_steps )
   ```

5. Modify the above command so that $\Delta t = 0.1$.

Now let's use the `euler` function to solve another differential equation:

$$y\prime(t) = \cos(t)\sin(y) \ , \quad y(0) = 15 \ . \tag{3}$$

1. Have matlab solve this equation using Euler's method from $t = 0$ to $t = 20$. Start with a small $n$ value.
2. Determine a good $n$ value as follows. Increase $n$, observing the plot of the solution. Keep increasing $n$ until the plot does not change significantly.

Next week you will complete and hand in some exercises where you use `euler` to solve some differential equations that arise from a physics problem.