# PHYS 3142 Spring 2021
# Computational Methods in Physics
# Assignment 11
# Due: 11:59 p.m. 2nd May 2021

Before you submit your assignment, do remember:

1. the due day
2. submit a report which contains your figures and results along with your code
3. make sure your code can run
4. do not forget to write comments in your codes.
5. label your figures and describle your results

The basic scoring rubric is :

1. **If you submit the assignment after the deadline or do not submit the report, you can only get up to 80% of grade**
2. **If there is any kind of plagiarism, all of the student involving will get zero mark! (except that the one can really prove the code is written by himself or herself and others copied it without telling him or her)**

## 1.Laplace's equation

Use the relaxing method to solve Laplace's equation for the two dimensional problem: a square box 1 m on each side, at voltage $V = 1$ volt along the top wall and zero volts along the other three. Use a grid of spacing $a = 1$ cm, so that there are 100 grid points along each wall, or 101 if you count the points at both ends. Continue the iteration of the method until the value of the electric potential changes by no more than $\delta = 10^{-6}V$ at any grid point on any step, then make a density plot of the final solution, similar to that shown in the following plots.

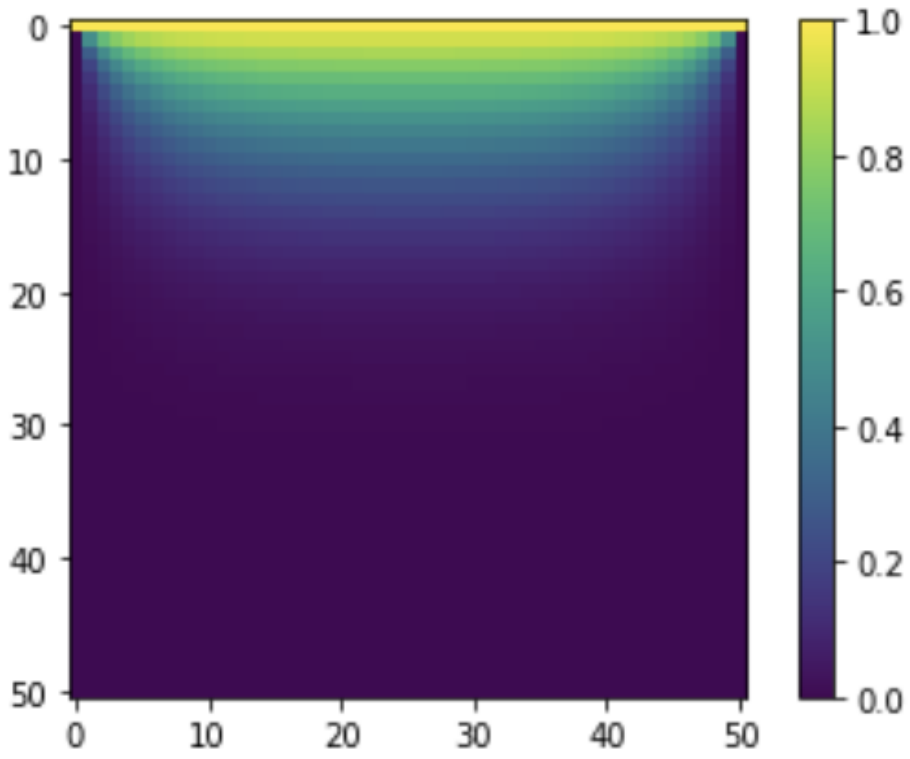


Figure 1:

## 2. electronic capacitor

Consider the following simple model of an electronic capacitor, consisting of two flat metal plates enclosed in a square metal box:

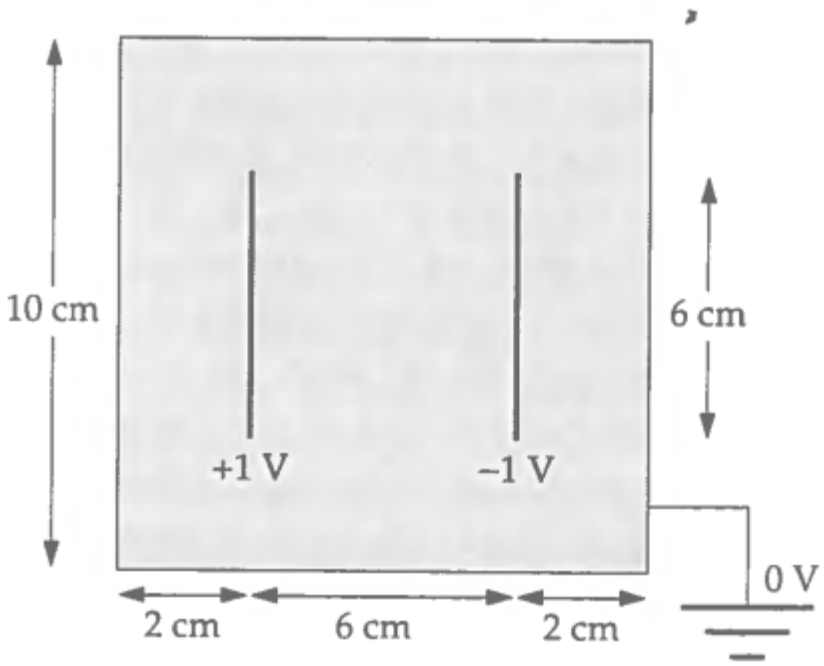


Figure 2:

For simplicity let us model the system in two dimensions. Using any of the methods we have studied, write a program to calculate the electrostatic potential in the box on a grid of 100*100 points, where the walls of the box are at voltage zero and the two plates(which are of negligible thickness) are at voltages $\pm 1V$ as shown. Please calculate the value of the potential at each grid point to a precision of $10^{-6}$ volts by the relaxing method and then make a density plot of the result.

### 3. Trajectory for the cannon ball [optional]

Now you are a gunner, you find a bomber is flying towards you. By measurement, you find this plane are directly flying to you. You fire decisively!

When you fire, the height of this bomber $1000m$, and it's exactly $2000m$ away from you. At that moment, It has a horizontal velocity 150 m/s. Since bombers usually drop bombs in advance, you need to hit it before it is close enough to you. Therefore, your cannonball must shot it down within about 4 to 8 seconds after being fired. Suppose you are stationary with the height 0 m, and the velocity of the bomber will not change. Now find possible trajectories which can shot the bomber down within 4 to 8 seconds. Plot all of them in one figure, and the the time interval should be smaller than 0.5 second.

The cannon ball should be consider at air drag. Now set its mass is 10 kg, the acceleration due to gravity is $g = 9.8$ m/s$^2$, the Radius of the spherical cannonball is $R = 0.08m$, the air density is $\rho = 1.22$, and the coefficient of drag is $C = 0.47$.And the air resistance on a moving sphere is a force in the opposite direction to the motion with magnitude

$$f_d = -\frac{1}{2}\pi R^2 \rho C v \tag{1}$$

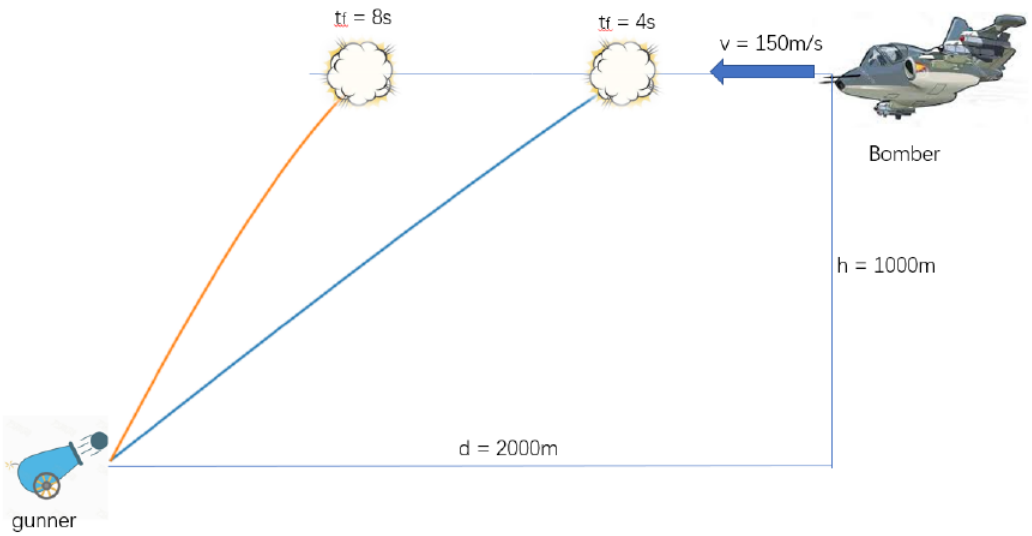


Figure 3: