AOOP Homework 4

Problem 1:
An ac current is described by the following equation:

$$i(t) = I_M \sin(2\pi ft + \phi)$$

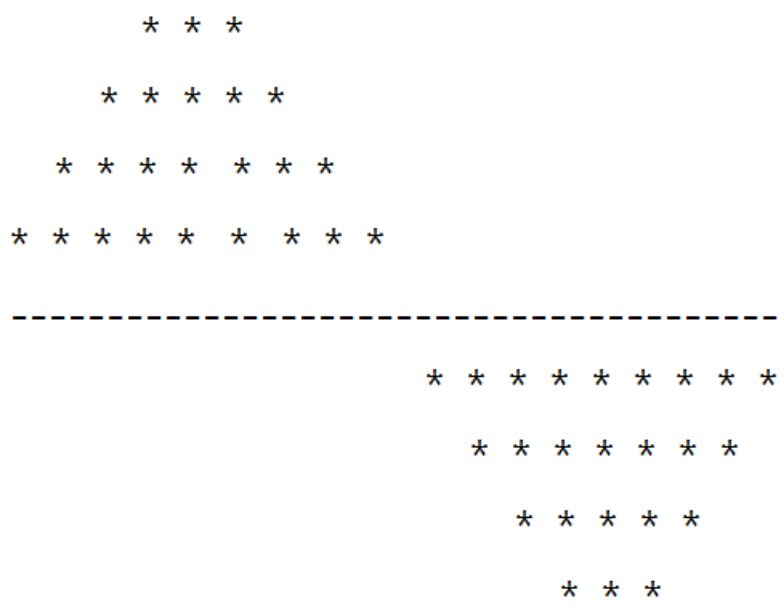
where I_M is the maximum value, f is the frequency, and ϕ is the phase shift of the current.
Design a program that simulates an analog-to-digital conversion. The program computes the current at various values of time t given in seconds for the number of time samples requested by the user. It should use a two-dimensional **dynamic** array to store the values of the current and the corresponding values of time t.

Assume f = 60 Hz.
The following input is requested from the user:

1. The maximum value of the current: I_M.
2. The phase shift: ϕ.
3. The number of time samples within one cycle: nt.

The program should first compute a tinc (time increment) and then compute the values of time t and corresponding values of the current for the required number of time samples.
Note: tinc = (1 / f) / nt

The program should output the values of the current for all time samples in a table format.
It should also use the values of the current stored in the two-dimensional **dynamic** array to present the current graphically in text mode. An example of the output could be as shown in the following figure:



Note: In the above example nt=18. Each value of the current is represented by a corresponding number of asterisks.

Note:

1. f = 60 Hz means: In one second , we have 60 sin waves.
   在一秒鐘有 60 個 sin 波.

2. 1/f means : The time for one sin wave.
   一個 sin 波 所需時 間

3. If we assume that in one sin wave, we have nt sample data
   我們假設在一個 sin 波中有 nt 個 data

4. Then the time increment to create the sin wave is
   tinc = (i/f) / nt
   我們每次去取樣時間為 tinc = (i/f) / nt

Problem 2:

Design a program that uses the “Spacecraft” class. This class should store and process the data of moving spacecraft, such as displacement, velocity, and acceleration in the x and y direction---as well as the time interval in which the spacecraft’s motion was processed. The program should obtain the values of the initial velocity and acceleration in the x and y direction from the user, as well as the time interval. It will then compute and display the craft’s displacement and velocity in the x and y direction every second within the time interval specified by the user. All input, output, and

data processing operations should be done by the “Spacecraft” class function members.

Note:

$$x = v_{0x}t + \frac{1}{2}a_x t^2 \qquad v_x = v_{0x} + a_x t$$

where x, v_x, v_{0x}, a_x *and* t are displacement, velocity, initial velocity, and acceleration in the x direction, and a moment of time within the time interval. The same equations are used to compute y and v_y, using the values of initial velocity and acceleration in the y direction.

請參考 plotting, 但是 Homework 要轉成逆時鐘旋轉 90 度(print out the array, you may take care about which array index for the inner loop and which array index for the outer loop.)

Plotting a Graph

1. Generate a table of number pairs :

t	*p(t)*	
0	30.0	
1	27.1	
2	22.6	
…	…	(for t= 0,…, n-1)

Or

i	x_i	y_i	
0	0.0	0.0	
1	2.0	32.0	
2	3.0	72.0	
…	…	…	(x_i , y_i for i=0,…, n-1)

These numbers may represent experimental data, say position *p(t)* vs. time *t* for a falling object or
may be generated from a particular functional relation between *x* and *y* as *y(x)*=8*x*^{2}

2. Determine the range of both x_i and y_i : A determination of both the

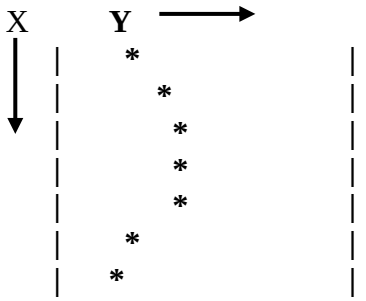
minimum and maximum
values of *x* and *y* in the data set :

$$(\text{Range})_x = (x_{max} - x_{min})$$

$$(\text{Range})_y = (y_{max} - y_{min})$$

These values are then used for scaling the *x* and *y* axes.
That is, adjusting the scales of the axes so that the graph fits neatly on the graph paper.

3. Step through the points and graph them one by one.



Note:
1.When one line is displayed, 80 or so characters will be printed for a particular value of ***x*.**
2. All of these characters will be blanks except one.
3. The position corresponding to ***y*** will contain some symbol --- e.g.,an asterisk.
4. To determine the proper placement of asterisk, consider the following:

$$y_{max} = 16.38 \qquad y_{min} = -7.21$$

so

$$(\text{Range})_y = 16.38 - (-7.21) = 23.59$$

Problem:
If at x= 3.0, y(3.0)=12.2,where in the horizontal line is the asterisk to be printed?

If the y axis is to be 81 columns wide, we could first define

$$\text{Ratio} = \frac{y(3) - y_{min}}{y_{max} - y_{min}}$$

Notice that ratio is between 0.0 and 1.0.
The appropriate column(position) for the asterisk is

IY = ceil (80 * Ratio)

For the particular choice of numbers above , y(3) =12.2

We obtain:

$$\textbf{Ratio} = \frac{12.2-(-7.21)}{23.59} = \textbf{0.82281}$$

IY =ceil(80 * 0.82281) = ceil(65.8248) =66

Where double ceil(double x)
Return 大於 x 值的最小整數

Note:

1. When y(i)= y_{min} **Ratio =0 then IY=80*0=0**

2. When y(i)= y_{max} **Ratio =1 then IY=80*1=80**

3. **最小值落在第 0 行，最大值落在第 80 行**
因此總共有 81 行