Lab 10 – Thursday July 19, 2019

This lab covers:

- Monte Carlo Technique (Pseudo Random Numbers)

Question 1

The purpose of this question is to write a python program (script) that that computes the area of an ellipse using the Monte Carlo technique.

Write a function that begins with the following header:

```
def MonteAreaEllipse(a, b, points):
```

The parameters ***a*** and ***b*** define the shape of the ellipse, and the parameter ***points*** is the number of random points to create. The ellipse is fully enclosed in a rectangle whose X coordinates range from $-a$ to $+a$ and whose Y coordinates range from $-b$ to $+b$. Use arrays to hold the X and Y coordinates of the points. Use the arrays and vector arithmetic to compute the probability that a point is inside the ellipse. Use vector arithmetic to compute the approximate area of the ellipse. There must not be any loops in this function.

A point is inside the ellipse if

$$\left(\frac{x}{a}\right)^2+\left(\frac{y}{b}\right)^2 \le 1$$

Return the area of the ellipse followed by the probability of a point being inside the ellipse.

Write a function that begins with the following header:

```
def main();
```

This function must:

- Input the value of **a** which is the length of the semi-major axis, input the value of **b** which is the length of the semi-minor axis, both **a** and **b** are real numbers.
- If either **a** or **b** is less than or equal to zero display an appropriate error message, otherwise do the following.
- If both **a** and **b** are greater than zero call *MonteAreaEllipse* to compute the approximate area of the ellipse using 10 million points.
- Calculate the actual area of the ellipse using the formula **π×a×b**.
- Calculate the error in the approximate area of the ellipse.
- Display:
  - the probability of a point being in the ellipse to 6 decimal places
  - the approximate area of the ellipse to 14 decimal places in exponential format
  - the actual area of the ellipse to 14 decimal places in exponential format
  - the error in the approximation in exponential format
- Call *displayTerminationMessage* to display the termination message.

The main program, not to be confused with the function named *main*, must contain the import statements, the function definitions and a call to the function named *main*.

A sample run of the program is shown below.

```
-----------------------------------------------------------------

Enter the length of the semi-major axis in cm (> 0): 10.75

Enter the length of the semi-minor axis in cm (> 0): 7.5

The probability of a point being in the ellipse is 0.785374
The approximate area of the ellipse is 2.53283276250000e+02 cm^2
     The actual area of the ellipse is 2.53290907695677e+02 cm^2
     The error in the approximation is 7.631446e-03 cm^2

Programmed by Stew Dent.
Date: Wed Jun 27 10:22:32 2018
End of processing.
```

Sample output for the length of the semi-major axis being too small.

```
-----------------------------------------------------------------

Enter the length of the semi-major axis in cm (> 0): 0
The semi-major axis must be greater than zero.

Programmed by Stew Dent.
Date: Wed Jun 27 10:24:12 2018
End of processing.
```

Sample output for the length of the semi-minor axis being too small.

```
-----------------------------------------------------------------

Enter the length of the semi-major axis in cm (> 0): 5

Enter the length of the semi-minor axis in cm (> 0): -1.25
The semi-minor axis must be greater than zero.

Programmed by Stew Dent.
Date: Wed Jun 27 10:27:44 2018
End of processing.
```