COP 2535: Data Structures

Exercise 04, Magic Numbers

1   Instructions

As a developer or programmer, one very important proficiency, and perhaps the most important proficiency, is the ability to understand abstract concepts and implement them into code that compiles, runs, and returns the correct response. In this exercise, you will convert four abstract concepts into code. The abstractions are expressed as mathematical equations, shown below. Also shown is my `main` function, and the expected output.

1.1   Instructions:

You are allowed to use *only* the appropriate repetition constructs (for, while), the appropriate selection constructs (if, switch), and the mathemetical and logical operators. *Do not use any builtin functions except those shown below.*

1.2   Square root of 2

Write a block that returns the square root of 2, 1.4142135623730951, to an acceptable error. The formula is shown by equation 1.[1]

$$\sqrt{2} = \left[F(n) = f\left(F(\frac{\frac{2}{n} + n}{2}) \right) \right] \tag{1}$$

1.3   pi

Write a block that returns π, 3.141592653589793, to an acceptable error. The formula is shown by equation 2.

$$\pi = \sum_{i=0}^{i=\infty} \left(\frac{4}{(i*4)+1} - \frac{4}{(i*4)+3} \right) \tag{2}$$

1.4   e

Write a block that returns e, 2.7182818284590455, to an acceptable error. The formula is shown by equation 3.

$$e = \sum_{i=1}^{i=\infty} \frac{1}{i!} \tag{3}$$

1.5   phi

Write a block that returns ϕ, 1.618033988749895, to an acceptable error. The formula is shown by equation 4.

$$\phi = \lim_{n \to \infty} \frac{F_{n+1}}{F_n}, F = \text{Fibonacci sequence, i.e., 1, 1, 2, 3, 5, 8, 13, 21, 34, etc.} \tag{4}$$

2   Template

You may use this template to get started. Please be sure to include the header.

```cpp
/************************************
        Name:
        Author:
        Date:
        Purpose: generate pi, phi, e, and sqrt(2)
        Input: none
        Output: generate pi, phi, e, and sqrt(2)
*************************************/

#include <iostream>
#include <cmath>
#include <iomanip>

using namespace std;

int main()
{
        cout << "--------------------" << endl;
        cout << "    Magic Numbers    " << endl;
        cout << "--------------------" << endl;

        cout << "Square root of 2 is ";
        double n = 1.0;
        double new_n;
    //your code here

        cout << setprecision(20) << n << endl;

        double e = 1.0;
        int denom = 1;
        cout << "The value of e is ";
    //your code here

        cout << setprecision(20) << e << endl;

        double pi = 0.0;
        cout << "The value of pi is ";
    //your code here

        cout << setprecision(20) << pi << endl;

        double current = 1, next = 1, temp;
        double phi;
        cout << "The value of phi is ";
    //your code here

        cout << setprecision(20) << phi << endl;

        return 0;
}
```

3   Output

Your deliverable is a text file that will look similar to this. You should be able to select your output screen, copy it (with Ctl-C), and insert it into the text entry box (Ctl-V).

```
--------------------
    Magic Numbers
--------------------
Square root of 2 is 1.4142135623730949234
The value of e is 2.7182818317703532074
The value of pi is 3.1415922369231532585
The value of phi is 1.6180339887498949025
```