ENG-101 Section I
Intro Computing Engineers

Due 10 September at 6:00pm

Question 1 (20 Points)

Write a well-documented Python program that computes the circumference of the Earth, which is assumed to be a sphere with radius 6370km. Recall that the circumference of a circle is related to the diameter by π. In this question estimate the value of π three ways – all using infinite series of Leibnitz, Nilakantha, and Adamchick.

The Leibnitz Series is: $\frac{\pi}{4} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots = \sum_{n=0}^{\infty} \frac{(-1)^n}{2n+1}$.

The Nilakantha Series is: $\frac{\pi}{4} = \frac{3}{4} + \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n+3)^3-(2n+3)}$.

The Adamchick Series is: $\pi = \sum_{n=0}^{\infty} \left(\frac{4}{8n+1} - \frac{2}{8n+4} - \frac{1}{8n+5} - \frac{1}{8n+6}\right)\left(\frac{1}{16}\right)^n$

Each series requires an infinite number of terms to define the constant π. Your code should prompt the user to provide an integer, N, the integer to evaluate the series with. For example, if the user selects N =4, each series is evaluated with four terms. In the case of Leibnitz, the estimate of $\pi \approx 4\left(\frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7}\right) = 2.895 \ldots$.

Your solution should be a Python text file *mypi.py*. Your first comment should be your name. In the last line of the Python text file, please provide an answer to the question, "What is the circumference of the Earth evaluated at 100 terms using the Leibnitz, Nilakantha, and Adamchick series?", as a comment.

Hints: Your program should use a for-loop in each of the series being calculated. Make sure your range operator evaluates the correct number of terms in the sum. Define each series as *functions lsm_pi nsm_pi, and aw_pi* to allow the functions to be reused in Question 2.

Hints: Consider the Abraham Series to Compute $\pi = \sum_{k=0}^{\infty} \frac{2\,(-1)^k 3^{\frac{1}{2}-k}}{2k+1}$.

Python Code to implement series is shown below.

```
# Abraham Series Method of Computing Pi
# n is the number of terms in the series

def abr_pi(n):
    tempPi = 0
    for i in range(0,n+1):                    # n is offset by 1
        denom = (2*i+1)
        numer = 2*(-1)**i*3**(1/2-i)
        tempPi += numer/denom
    return tempPi

# Prints 10th, 100th, 1000th Terms

def main():
    print('Tests Abraham Series ')
    for i in range (1,4):
        print(str(10**i) + 'th series ' + str(abr_pi(10**i)))
```

Question 2 (20 Points)

Write a well-documented Python program that determines the number of terms in the infinite series of Nilakantha, Leibnitz and Adamchick to obtain a specified level of precision with the actual value of π, as computed by Python's math module. Your program prompts a user for an integer M. Your application identifies the number of terms N to achieve an estimate of π within 10^{-M}.

Submit your solution in a Python text file *whilemypi.py*, using the functions developed for the series in Question 1.

Hints: Your program code should import math as m. Using a while loop, continue to evaluate the series until it is within the tolerance of 10^{-M} of Python's π. Use the absolute value function in your evaluation.

Next Steps (not graded, not to be handed in): Embed your solution into a for-loop that iterates N from 1/1,000 to 1/1,000,000,000,000 in powers of ten to determine the level of precision. Suppress your answer for Leibnitz Series to avoid long computational times.