uOttawa General Engineering (GNG)

GNG1106 - Lab 5

Objectives

1. Master the use of loops in C.
2. Use C to calculate e^x, cos(x), sin(x) and tan(x):
3. Learn to test and debug your program and develop a good programming habit.

Instructions

It is not allowed to use trigonometry functions math.h in this lab.

Pre-Lab Submission (20%): Ensure you have submitted your pre-lab before attending the lab session.

Deliverable 1 (30%): The expression of cos(x) for any angle x (in radian) in terms of the sum of an infinite series is:

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots$$

$$= \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!} \approx \sum_{i=0}^{N} t(n)$$

$$\text{with } t(n) = t(n-1)\left(\frac{-1}{2n\cdot(2n-1)}x^2\right) \text{ and } t(0) = 1.$$

Write a program that asks the user to enter an angle in degrees and the program will compute the cosine value of that angle by approximating the above sum of the infinite series. Note that the magnitude of *t(n)* decays with *n*, and the accumulation of the terms *t(n)* should be terminated when *t(n)* falls in ±0.0000000000001. Run your code with test cases x=0°, x=60°, x=120°, x=180°, x=300°.

Deliverable 2 (30%): Recall the expression of the tangent function: tan(x)=sin(x)/cos(x). Write a program that asks the user to enter an angle in degrees and the program will compute the tangent value of this angle using this formula, where computing cos(x) follows the instructions in Deliverable 1 and computing sin(x) uses a similar approach (i.e., approximating the sum of an infinite series while dropping terms within ± 0.0000000000001). Run your code with test cases x=0°, x=60°, x=120°, x=180°, x=300°.

Deliverable 3 (20%): We know that the calculation of tan(x) can give an indeterminate value (infinity) in the case of a division by zero (for example, x= 90°). You are asked to improve the code of Deliverable 2 above to display "tan(x) = infinity" if x is within ± 0.0000001 of any angle whose tangent value is infinity. Run your code with the test cases x=0°, x=90°, x=120°, x=180°, x=270°.

Check out and Submission

You must check out with your TA before submitting the deliverables. During the check out, your TA may inspect your work and to-be-submitted deliverables, and ask you questions to further check your understanding. At the end of the check out, your TA will give you an initial mark for the in-lab component of this lab and let you know. You must then submit the deliverables before the due time of this lab. While this initial mark is likely to be the final, your TA reserves the right to reduce this initial mark after checking more carefully the deliverables you submit.

Grading Criterion:

- **Correctness (60%):** Correct syntax, logic and execution.
- **Style (40%):** Descriptive variables names and appropriate indentation (especially those in the loops).