Laboratory Programming Exercise 05
Computer Engineering 160
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In Laboratory Programming Exercise 04 we saw the coefficients of the Maclaurin series expansion for *cos(x)* form the alternating series

$$1, -\frac{x^2}{2!}, \frac{x^4}{4!}, -\frac{x^6}{6!}, \cdots, \frac{(-1)^k x^{2k}}{(2k)!}$$

A similar alternating series can be derived from the Bessel function ***J₀(x)***, which describes electromagnetic waves in a cylindrical waveguide

$$1, -\frac{x^2}{2^2}, \frac{x^4}{2^2 4^2}, -\frac{x^6}{2^2 4^2 6^2}, \cdots, \frac{(-1)^k x^{2k}}{2^{2k} (k!)^2}$$

Let $n = 2k$. Then, the denominator of a *cos(x)* function series coefficient has an *n!* term, while the denominator of a Bessel function series coefficient has a $2^2 4^2 \cdots n^2$ term. This latter product can be expressed as

$$2^n \left[\left(\frac{n}{2} \right)! \right]^2$$

Within an iterative structure, compute the ratio of the k^{th} *cos(x)* coefficient to the k^{th} Bessel coefficient, i.e.,

$$\frac{\left[\dfrac{(-1)^k x^n}{n!} \right]}{\left[\dfrac{(-1)^k x^n}{2^n \left[\left(\frac{n}{2} \right)! \right]^2} \right]}$$

for 10 iterations. In your output, show that the ratio approaches $\sqrt{\pi n / 2}$. There is no need to prompt for input. During each iteration, output the value of the iteration index *k*, the k^{th} ratio, and the k^{th} approximation error

$$\text{error}_k = \left| \text{ratio} - \sqrt{\pi n / 2} \right|$$

Once you have this part working, modify your program to use *Stirling's* formula to approximate *n!*

$$n! \approx \sqrt{2\pi n} n^n e^{-n}$$

to avoid a nested loop to compute a factorial. Verify your program works using *Stirling's* approximation. Generate a screen capture of your Eclipse IDE workspace, showing your code and the output of your program in the terminal. Please name your Eclipse IDE project `Lastname_REDID_Lab_05`. Create a ZIP file of your project folder and submit the ZIP file through Blackboard.