University of Massachusetts Lowell
Department of Electrical and Computer Engineering
16.520 Computer Aided Engineering Analysis
Problem set 1

Note: all arguments must be passed by reference

1. Consider a N sided regular polygon inscribed in a circle of radius equal to 1/2. The number of sides is given by $N = 2^m$ where $m = (2, 3, \ldots)$. When $m = 2$ the perimeter of the square is equal to $p_2 = 2^2 sin(\pi/2^2) = 2\sqrt{2}$. Note that as did Archimedes that as N approaches infinity $p_\infty = \pi$.

a. Show that perimeter of a 2^m sided polygon is equal to

$$p_m = 2^m \sin(\pi/2^m)$$

b. Using the half angle formula can obtain the recursion

$$p_{m+1} = 2^{m+1/2} \sqrt{1 - \sqrt{1 - \left(\frac{p_m}{2^m}\right)^2}}$$

where $p_2 = 2\sqrt{2}$. Write a single precision program in Fortran or C to evaluate p_m as a function of m for $m = 3, \ldots, 14$. Using gnuplot plot the error $|p_m - \pi|$ versus m using a log y-axis and linear x-axis. Obtain a hardcopy of the result. Using this result what is the value of m that yields the minimum error.

2. Consider the product form expression for $sin(x)$

$$sine(x, NTERMS) = x \prod_{n=1}^{NTERMS} (1 - \frac{x^2}{p_n^2})$$

where $p_n = n\pi$ the zeroes of sine. As $NTERMS$ approaches ∞ $sine(x, NTERMS) \rightarrow sin(x)$.

a. Write a single precision function routinue in Fortran or C to evalute the aforementioned expression. The function should labeled $sine(x, NTERMS)$ and return a real valued floating point result. The arguement x is real and $NTERMS$ is integer valued.

b. Compare your result and the exact result graphically using $NTERMS = 20$ for $0 \le x \le 2\pi$ at $x = k\Delta x$ where $k = 0, NPTS - 1$. $NPTS = 100$.

c. How many terms are required to yield an absolute error, $|sin(x) - sine(x, NTERMS)| < 10^{-3}$.

3. Download port3, unzip, untar, make library. Place the library libport3.a in your ~/lib directory. Test library using given examples. Be sure to tell to complier where the library is using the -L~/lib option and -lport3 in gfortran.