EE774 - Lab 2

For all the problems below, please adhere to the following:

- Put each C source file in a separate directory, such as `prob1`, `prob2` etc.
- Add a `Makefile` in each directory to build the source code
- Try to accept the file input as a command line argument. Examples have been provided in class.
- Submit the assignment as a single `zip` or `tar.gz` file with all the subdirectories.

1. (10 points) We want to solve the equation

$$\cos(x) - 0.6x = 0$$

using the Newton-Raphson method, with $x = 0$ as the initial guess. Let $f(x) = cos(x) - 0.6x$.

   a. Plot $f(x)$ with gnuplot to obtain the solution of $f(x) = 0$ (approximately).

   b. Write a C program to solve $f(x) = 0$ using the N-R method. Set the tolerance for $|f(x)|$ to 10^{-12}.

   c. Run your program and find the minimum value of $|f(x)|$ obtained by the N-R method in 20 iterations using (a) `float`, (b) `double` numbers. Print (on the console) the iteration number, x, and $f(x)$ in `%16.9e` format. Note the difference between the float and double solutions.

   d. (Optional) Write suitable data to a file(s) to see graphically how the N-R method converges to the solution.

2. (10 points) Write a C program to solve a nonlinear equation $f(x) = 0$ with the N-R method. The program should take as inputs from the command line the initial guess x_0, the maximum number of iterations $N_{\max}$, the tolerance ϵ for $|f(x)|$, and the damping factor k.
   Use the program to solve the following equations. If the (standard) N-R iterations do not converge in $N_{\max}$ iterations, try using a suitable damping factor. Plot $\log|f(x)|$ versus iteration number in each case. In each case, plot $f(x)$ using gnuplot and check that you have indeed obtained the root (or one of the roots).

   a. $f(x) \equiv 2x^3 + 5x^2 - 22x + 15 = 0$, $x_0 = -10$.

   b. $f(x) \equiv 2x^3 + 5x^2 - 22x + 15 = 0$, $x_0 = 0$.

c. $f(x) \equiv \cos x - e^{-x/2} = 0,\ x_0 = 1.$

d. $f(x) \equiv \tan^{-1} x = 0,\ x_0 = 0.5.$

e. $f(x) \equiv \tan^{-1} x = 0,\ x_0 = 1.5.$