Lab Assignment I

1. This example illustartes loss of significance due to cancellation. Write a program which calculates the real roots of the quadratic equation $x^2 - 0.4x - 0.8\epsilon_k = 0$ where $\epsilon_k = 10^{-k}$. The real roots of the equation $ax^2 + bx + c = 0$ are given by

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad (\text{ assuming } \quad b^2 \geq 4ac)$$

Here x_1 represents the root with larger magnitude. For example, if $b < 0$, then $x_1 = (-b + \sqrt{b^2 - 4ac})/2a$. Note that x_2 can be alternatively computed as $x_{2a} = c/ax_1$. Write a C program *cands.c* that calculates x_1, x_2, x_{2a} using single precision (*float*) for real variables and prints in a table as shown below. The program also prints the size of float for the machine. The roots are printed using exponetial format with 6-place after decimal. Output of your program should appear in places marked (- - -).

```
Size of float --- bytes
k          x1                x2          x2a
1    3.788854e-01       2.111456e-02    2.111456e-02
2       ---               ---            ---
3       ---               ---            ---
4       ---               ---            ---
5       ---               ---            ---
6       ---               ---            ---
```

Copy the same program to file *candd.c* and use *double* instead of float. Produced a similar output as above. Observe the difference in output for the two programs.

2. This example illustartes the opposite effects of truncation error and rounding error. Note that derivative of a function $f(x)$ at x is given by

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

We approximate $f'(x)$ by taking small value of h. Write a program *deriv.c* that calculates the derivative of $f(x) = \sin x$ at $x = 1$. The exact answer is $f'(1) = \cos(1)$ and we can calculate the absolute error from $|f'(1) - f'_h(1)|$, where $f'_h(1)$ is the approximate $f'(1)$ with a given h. The program prints the output in a tabular format as shown below where $h = 1/10^k$ ($k = 1, 2, \cdots, 18$). Output of your program should appear in places marked (- - -). Print the real variables in exponetial format using 6 decimal places. Use *double* for real variables. One output is shown.

```
k       h              fh'(1)            f'(1)          Abs. error
 1  1.000000e-01    4.973638e-01       5.403023e-01    4.293855e-02
 .  .               .                  .                 .
 .  .               .                  .                 .
18  ---              ---                ---              ---
```