

Lab 4: Working with Files

Objective

The objective of this lab is to learn to solve engineering problems using C++. We will focus on these issues:

- Understand the requirements of a problem and the algorithm/pseudo code solution
- Implement the **modular** solution using C++ **using functions**
- **Realize persistence by writing results out to files.**
- **Input data from files.**
- Debug and remove errors
- Test and verify the correctness of the results

Description

For this lab, you will solve problems that are described below: (Problem 2 is from G. Bronson's C++ textbook¹)

1. Write a program **Lab4a.cpp** that processes text in a file according to these rules:

- it converts all upper case letters in the text to lower case,
- all lower case letters to upper case and
- leaves all other characters unchanged.

Prepare an input file **Lab4a.txt** that contains the text² given below. You can do it by copying the text from here, pasting it into Notepad and save the file as **Lab4a.txt**. Read this file from within your program. Recognize the end of input file using **eof()** function. Write the output into file **Lab4a.out** from within your program. Do not simply copy the output from the output screen into a file. Submit the files Lab4a.cpp, Lab4a.txt and Lab4a.out

For each set of relations the calculator is used by selecting the variable to input, typing in its value, and then pressing the calculate key. For example, to compute the flow properties corresponding to a Prandtl-Meyer angle of 20 degrees, go to the 'Isentropic flow relations'. Click on the field immediately following 'INPUT:' that says 'Mach Number' and select 'P-M angle (deg.)'. Replace whatever is in the next field (adjacent to the 'Calculate' button) with 20 and press 'Calculate'. Output is displayed in the table immediately following.

*Values from the output (or input) fields may be copied and pasted to any input field or to the 'Scratch pad' at the bottom of the screen. The scratch pad is for performing the miscellaneous calculations necessary when using the Calculator to solve an aerodynamics problem. Arithmetic expressions typed into the left-hand box of the scratch pad are computed and the result displayed in the right-hand box. Results may be pasted into the input fields of the Calculator. Expressions may contain the operators */+- (no ^ or **), the functions pow(), sqrt(), exp(), log(), abs(), sin(), cos(), tan(), asin(), acos() and atan(), and parentheses. Note that all angles are assumed to be in radians and that out-of-range functions (e.g. sqrt(-1)) return zero.*

2. A model to estimate the number of grams of a certain radioactive isotope left after N years is given by the formula **Remaining material = (Original material) * e^{-0.0012N}**. The **radioactive** half-life for a given radioactive isotope is the time for **half** the radioactive nuclei in any sample to undergo radioactive decay. Write a program that takes as input amount of original material and outputs a sequence of pairs of information (year, remaining material).. Start with N=0 and increment every time by 10 until the half-life is reached. Save the output in a file: **Lab4b.out**. For example for an input of 250 grams the output in the file would be in the following format:

```
Years , Remaining Material
0 , 250
10, 247.018
20,244.071
Etc.
580,128.644
```

¹ C++ for Engineers and Scientists, Gary J. Bronson, Brooks/Cole Thomson Learning, 1999.

² From <http://www.engapplelets.vt.edu/>

Note: For this problem you can enter the input (e.g. 250) using the keyboard. Only the output has to be saved into a file. Submit files **Lab4b.cpp** and **Lab4b.out**

3. This problem deals with equations for motion of objects in two dimensions. In particular we will look at projectile motion as discussed in the web resource:

<http://www.glenbrook.k12.il.us/gbssci/phys/Class/vectors/u3l2b.html>. We are interested in the height and distance of the projectile with reference to time. The formulae for these two are readily available at another web resource: <http://www.egwald.com/geometry/projectile3d.php> and are repeated below. Assume that the projectile is fired from a gun that is mounted on a cliff above the sea.

z_0 = height of the gun above the x-y plane in meters.
 v_0 = muzzle velocity = initial velocity of the projectile in meters/sec.
 α (alpha) = the angle between the horizontal (the x-y plane) and the muzzle of the gun in radians.
 $z(t)$ = the height of the projectile t seconds after being fired (meters).
 $r(t)$ = the distance of the projectile from the gun after t seconds (meters).
 g = pull of gravity (9.81 meters/sec).

Then the parametric equations of motion of $(r(t), z(t))$ are:

$$r(t) = v_0 * t * \cos\alpha$$

$$z(t) = (-1/2 * g * t^2) + (v_0 * t * \sin\alpha) + z_0$$

You will input z_0 , v_0 , and alpha and compute distance and height of the projectile at various time intervals until the projectile reaches ground. Your program should repeatedly compute the distance and height and output them in a tabular form. Your output will contain the data computed by the equation for the distance and height against time values.

- Assume that z_0 is 10.5 and v_0 is 6.5. You can assign these values inside the program.
- Input the angle of launch in degrees and convert it to radians get alpha.** (radians = degree * PI/180.0) Compute a set of $r(t)$ and $z(t)$ values till the projectile reaches the ground (i.e. till $z(t) \leq 0$) and write the set to a data file called "**Lab4c.out**". It will have four columns (no column headings needed), launch angle in degrees, time, distance and height. A sample data set (incomplete) generated is shown below:

```
.....
15  0.3  1.88356 10.5632
15  0.31 1.94634 10.5501
15  0.32 2.00913 10.5361
15  0.33 2.07191 10.521
.....
```

Submit: Lab4c.cpp, Lab4c.out

For each solution you will develop an algorithm in pseudo code, then develop and execute a C++ program using the VC++ environment.

4. Extra problem: p.283, problem #14. Make sure BINO.DAT contains at least 20 data sets.

For each solution you will develop an algorithm in pseudo code, then develop and execute a C++ program using the VC++ environment.

Visual C++ Environment and Workspace Structure

In order to keep your lab work organized we will maintain them in a structure as shown below: You will add project Lab4a through Lab4d to the EAS230A/EAS230B workspace already created for your first lab. Each of the Lab4x will host the C++ program for the problem stated above.

Template for Program Header

Place the following code at the beginning of every source code file (.cpp) that you submit for this class.

```
/******  
* NAME: your name *  
* PERSON NUMBER: your person number *  
* PROGRAM: Lab name *  
* PURPOSE: 1-2 line summary of the purpose of the lab *  
* DATE: Date of last update *  
* PLATFORM: Microsoft Visual C++ 6.0 Pro *  
* Course & Section: *  
*****/
```

On-line submission of your code

All source code (.cpp) will need to be submitted using the on-line command which will be given to you during the lecture and lab. The procedure for submission is as follows:

From your unix command-prompt, do the following:

change directories to where your files are located

run the following command for each file

- o `submit_eas230a <file>`
 - where `<file>` is the name of the file you need to submit.
 - For eas230b `submit_eas230b <file>`
- o You will have to change directory (`cd`) to be in the correct directory where the .cpp file located. Ask your TA for help on this.
- o You will submit four c++ source files: Lab4a.cpp, Lab4b.cpp, Lab4c.cpp, Lab4d.cpp
- o You will also submit input/output files Lab4a.txt, Lab4a.out, Lab4b.out and Lab4c.out, BINO.dat
- o As and when you finish a program, go ahead and submit it. Don't wait till the last minute to submit all at once. You can submit a file multiple times; the last submission will be graded.

Evaluation

Lab4a 30%

Lab4b 30%

Lab4c 30%.

Lab4d 10%

File operations are worth 15% of the total Lab4 grade. Also you need to demo the labs to one of the TAs during the lab hours, office hours or extra help hours. 10% of the total grade is for the demo.