These must be completed and shown to your lab TA either by the end of this lab, or at the start of your next lab. You may work in groups of up to two people.

This is an introduction to C++ through some simple activities. You should also read the C++ Primer in your textbook, and practice as much as possible.

First, you'll need to login to your CompSci ugrad account (it will look like "r2d2" or "c3p0a"). If you don't have one yet, login with userid "getacct" (with no password) to obtain it. (And if you're reading this before your lab, webpage `https://www.cs.ubc.ca/getacct/` does the same thing.) Once you're logged in, at the command line enter the following to create a directory to hold your cs221 files, another subdirectory for this lab, and to navigate there (the semi-colon allows several commands on one line):

```
mkdir cs221; cd cs221
mkdir lab1; cd lab1
```

First you'll compile and run two programs that demonstrate input and output in C++.

Q1. Program 1 (terminal I/O): Copy+paste the lines from `sample_code.cc.txt`. There are many ways to do this. For this lab just open a web browser and navigate to the course Lab/Lecture Notes webpage, click on Code Samples from the Lab (it works from here too), highlight the lines and copy them to the clipboard. Now back at the command line, enter:

```
gedit q1.cc
```

Be patient, it might complain about some sub-process failing but it will invoke a fairly intuitive GUI text editor. Paste the saved lines (Ctl-V even on a Mac) from the clipboard into the empty file. If you've been following along with the commands, your current directory should be `~/cs221/lab1` and if it is, then just save and close. If it isn't, "Save As" instead (i.e. save `q1.cc` in `~/cs221/lab1`) and after you exit gedit, enter the following to make `~/cs221/lab1` your current directory:

```
cd ~/cs221/lab1
```

These are the lines that should be in `q1.cc`

```
#include <iostream>               // needed for cin and cout
float circle_area(float radius);  // declare function prototype

int main(void) {
  float circle_radius;
  std::cout << "Enter radius:" << std::endl;
  std::cin >> circle_radius;
  std::cout << "Area is: " << circle_area(circle_radius) << std::endl;
  return 0;
}
float circle_area(float radius) {
  return 3.14159 * radius * radius;  // = pi * r^2
}
```

You can check to see what is actually there by entering: `cat q1.cc`

To compile your program, enter: `g++ -Wall q1.cc -o q1`

After you get a clean compile, run your program by entering: `./q1` That's period-slash-executable. Your sub-directory isn't in the default PATH, so you have to tell the machine where to find your executable. The period says "this sub-directory", the slash is just the usual delimiter after subdirectory names, and "q1" is the name of the file you told `g++` to put the output in (that's what the "-o q1" did in the compile command above).

Q2. Program 2 (file I/O): First create a file called "infile.txt" containing at least 6 lines of text, and another file called "q2.cc" containing the following code. Compile and run as in Q1.

```
#include <iostream>
#include <string>
#include <fstream>

int main(void) {
  std::ifstream in ("infile.txt");      // input file-stream
  std::ofstream out ("outfile.txt");    // output file-stream
  std::string ss;
  // Put next line in ss (discards any newline chars)
  while (getline(in, ss))
    out << ss << std::endl; // add line to out (with newline)
  std::cout << "End of program" << std::endl;
  return 0;
}
```

Notice that these files are called "streams". In Q1, `std::cin` used `>>` to extract a value from the input stream and store it in a variable. An `ofstream` (or `std::cout`) uses the `<<` operator to add to the output stream.

Also, a string Object is used to hold each line of text. You might have heard of a C-string, which is a sequence of char that terminates in a NULL char (0x00), and might have seen them used in programs:

```
char* err_msg; // in some C or C++ program
```

A string Object and a C-string are not the same thing at all. The former has constructors and methods, while the latter is actually just the address of one char – by convention we interpret this as a C-string by including all characters up until a 0x00 is encountered.

To check that q2 copied the file correctly, compare input.txt and output.txt side by side by entering:

```
sdiff infile.txt outfile.txt
```

Q3. Write another program called `q3.cc`, and in it declare a global array with 10 elements. (Compile and run as in Q1 and Q2.)

(a) Write a function called `fill_array` (with no parameters) to fill the elements of the global array with the numbers 1 through 10. Call this function from `main()` and after it returns, print the contents of the array to the screen.

(b) Modify the function (and its call) so that it accepts two integers as parameters. The first integer represents the value to be assigned to the first element, the second integer represents the increment between each element. As before, the contents of the array should be printed to the screen after `fill_array()` returns to `main()`. Only your work for part (b) needs to be checked by your TA.

For example (part b): `fill_array(4,2)` fills the array with the numbers 4, 6, 8, 10, 12, 14, 16, 18, 20, 22. `fill_array(0,5)` will fill it with 0, 5, 10, 15, 20, 25, 30, 35, 40, 45.

Your `fill_array()` function prototypes should look like:

```
void fill_array(); // for part (a)
void fill_array(int first_value, int increment);// for part (b)
```

And your calls to `fill_array` in main should look like this:

```
fill_array(); // for part (a)
fill_array(4, 2); // for part (b) (4 and 2 are examples)
```

Q4. (command-line input and recursion) (from Wikipedia) The Towers of Hanoi is a mathematical game or puzzle. It consists of three pegs (called A, B and C), and a number of disks, n, of different sizes which can slide onto any peg.

The puzzle starts with the disks neatly stacked in order of size on peg A, the smallest at the top, thus making a conical shape. The objective is to move the entire stack to peg C, obeying the following rules:

- Only one disk may be moved at a time.
- Each move consists of taking the upper disk from one of the pegs and sliding it onto another peg, on top of the other disks that may already be present on that peg.
- No disk may be placed on top of a smaller disk.

Your task is to write code to solve the Towers of Hanoi problem for n disks. **HINT: Use recursion.**

To move n disks from A to C:

(a) Recursively move $n-1$ disks from A to B. This leaves disk n alone on peg A.

(b) Move disk n from A to C.

(c) Recursively move $n-1$ disks from B to C so they sit on disk n.

Don't forget to check the base-case when using recursion. (What is the base-case in this problem?)

Your program should take a small integer n as input from the command line and invoke the `moveDisks()` function using code like this:

```
#include <cstdlib> // for atoi
#include <iostream>
// prototype
void moveDisks( int n, const char* FROM,
const char* VIA, const char* TO);

int main(int argc, char *argv[]) {
  if (argc != 2) {
    std::cout << "Usage: " << argv[0]
      << " number_of_disks" << std::endl;
    return -1;
  }
  moveDisks( atoi(argv[1]), "peg A", "peg B", "peg C" );
  return 0;
}
// put your moveDisks() function here
```

It should produce output to solve the problem with n disks, The output of my "hanoi 3" is:

```
Move disk from peg A to peg C
Move disk from peg A to peg B
Move disk from peg C to peg B
Move disk from peg A to peg C
Move disk from peg B to peg A
Move disk from peg B to peg C
Move disk from peg A to peg C
```

Q5. Write a program that simulates a guessing game. It should randomly generate a number from 1 to 100, and ask the user to input a guess. The game should keep running until the user gets the number correct, or otherwise indicates that they wish to end the game.

You will need the following functions:
`http://www.cplusplus.com/reference/cstdlib/srand/` (use `srand(0)` until your program is debugged)
`http://www.cplusplus.com/reference/cstdlib/rand/`
`http://www.cplusplus.com/reference/cstdlib/atoi/` (alpha-to-integer)

Some other useful commands and tips

`cd ..`	change directory to the parent of the current directory
`cd ../..`	change directory to the parent of the parent of the current directory
`cd`	change directory to your home directory (the same as where you are when you first log in)
`ls`	list the files in the current directory
`ls -alF`	list all info about the files in the current directory, one per line ("l" is lowercase L)
`ls -1 > DIR.txt`	list the names of the files in the directory, one per line ("-1" is minus-one) and put the output in `DIR.txt` (this can be useful when creating the initial version of a `README.txt` file, for example)
`cat DIR.txt`	print the contents of `DIR.txt` to the screen
`rm fn.ext`	remove (delete) the file named `fn.ext` from current directory
`rm -f *.*`	remove all files in current directory (**careful**) without confirmation
`rmdir dir`	remove directory named `dir` (which *must* be empty)
`bye`	log off

Use up-arrow (↑) and down-arrow (↓) to cycle through your previous commands.

To write your C++ programs, we recommend editing and compiling on a ugrad machine using `gedit`, `jedit` (cross-platform, since it's in Java!), `kate`, `emacs`, or `vim` to edit and gnu's version of `g++` to compile. You *can* use XCode or VisualStudio or Eclipse or any other IDE, but we do *not* support these and your code **must compile and execute** on a ugrad machine (outside of any IDE). See `http://www.ugrad.cs.ubc.ca/~cs221/current/computing.shtml`.

You can login to a ugrad machine remotely from home assuming you have an internet connection and a ugrad account:

If you a running a Mac, you can just open a Terminal window and type:

```
ssh a1a1a@remote.ugrad.cs.ubc.ca
```

Of course you can also compile and run your code locally (in Terminal).

If you are running Windows, you'll need "Xmanager" (available free from the Department at `https://my.cs.ubc.ca/docs/free-terminal-emulation-software-xmanager` follow the instructions on that page) to access your ugrad account remotely. To compile and run locally on a Windows machine, you can use Cygwin, a *nix machine emulator which runs under Windows, from `https://www.cygwin.com/`. Select the "Devel" category or you will not be able to compile anything. If you forget, you can add the "Devel" stuff later without installing everything again.