600.120: Intermediate Programming
Final Exam

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Time: 40 Minutes

Start here: Please fill in the following important information using a **permanent pen** before you do **anything** else! Your exam will **not** be graded if you use a pencil or erasable ink on this page.

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Ethics Pledge: With your signature you **certify** the information above and you also **affirm** the following: "*I agree to complete this exam without unauthorized assistance from any person, materials, or device.*"

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Instructions: Please read these instructions carefully before you start. **Switch off** your phones, pagers, and other noisy gadgets! You are **not** allowed to have anything but a pen (pencil, eraser) and this exam on your desk. You are **not** allowed to talk to anyone during the exam. If you have a question, please raise your hand **quietly**. You must **remain seated quietly** until all exams have been collected. Remember that you can **not** claim grading errors if you do not use a **permanent** pen for your answers.

Do not open before you are told to do so!

You got _____ out of 40 points.

1 Binary Warmup (12 points)

For each of the following statements, determine whether it is either **true** or **false**. **(1 point each)**

1. In C, the keyword `static` for global declarations hides them from other modules.

2. Assume `int i=42`; in C, the expression `0 < i < 20` evaluates to `false` (or `0` if you prefer).

3. Assume `int *pi=NULL`; the expression `pi!=NULL && (*pi)++` leads to a runtime error.

4. In C, the `[]` operator is defined by the following equivalence: `a[i]` ⇔ `*(a+i)`.

5. As opposed to references, pointers in C++ do not have to be initialized when they are declared.

6. In C++, we can define how an object gets converted to type `bool` by overloading `operator[]`.

7. Abstract classes in C++ must have at least one pure virtual member function.

8. In C, the `sizeof` operator is one of the few that can take a type as its argument.

9. In C, the `->` operator is defined by the following equivalence: `x->y` ⇔ `[x]+y`.

10. The new C++ operators for casting are generally faster than the old ones.

11. The purpose of UML class diagrams is to show as many implementation details as possible.

12. The `splint` tool is used to measure how much time is spent in each function of a C program.

2 Tough Choices (8 points)

For each of the following questions, circle **one** answer out of the choices given. **(2 points each)**

1. In C, what does the declaration `int (*comp)(void *, void *)` refer to?
   (a) A function pointer taking two generic pointers as arguments and returns a pointer to an integer.
   (b) A function taking two generic pointers as arguments and returning a pointer to an integer.
   (c) A function pointer taking two generic pointers as arguments and returning an integer.
   (d) The declaration is not legal.
   (e) None of the above.

2. Which of the following is **not** a valid application of the keyword `static` in C?
   (a) We can hide global declarations and definitions from the linker by making them `static`.
   (b) We can preserve local variables between function calls by making them `static`.
   (c) We can write-protect strings by making them `static`.
   (d) All of the above.
   (e) None of the above.

3. Assume `int a[10]` and `int b[10]`; what does the instruction `a = b` do in this context?
   (a) All values stored in the array `b` are copied into the array `a`.
   (b) A pointer to the first element of the array `b` is copied into the pointer `a`.
   (c) The first element of the array `b` is copied into the first element of the array `a`.
   (d) The instruction is not legal and will result in an error message from the compiler.
   (e) None of the above.

4. Imagine a function that takes an argument declared as `const char *s`. What **exactly** is "constant" **inside** that function?
   (a) The pointer `s` is constant, so `s = NULL` is illegal.
   (b) The pointee `*s` is constant, so `s[0] = 0` is illegal.
   (c) Both (a) and (b) are correct.
   (d) You must be thinking of `final` and not `const` here, so the question is ambiguous.
   (e) None of the above.

3 Short Answer (8 points)

For each of the following questions, answer in **one to three** sentences, the shorter the better. **(2 points each)**

1. This is a **two-part** question about C++. First, under what circumstances is it **necessary** to define copy constructors and assignment operators? Second, what is the **difference** between copy constructors and assignment operators? **Explain!**

2. In C the array `int a[15]` has 15 elements indexed from 0 to 14; how can you set up `int *b` to access the same array indexed from -7 to 7? For example, `b[-2]` should access `a[5]`. **Explain!**

3. The keyword `const` in C++ is used for a lot of different things. Give an example that shows at least **three** distinct uses of `const` and discuss what they mean. **Explain!**

4. In C++ destructors can be **virtual** or **non-virtual**. Under what circumstances should a destructor be virtual? When can you get away with a non-virtual destructor? **Explain!**

4 Array Reversals (6 points)

Give a C function `reverse` that takes an integer array and its length as arguments and **reverses** the array **in place**. In other words, if `int a[] = {10, 20, 30, 40}` initially, then after the call `reverse(a, 4)` the elements of `a` are now `{40, 30, 20, 10}` respectively.

5 Objective Classes (6 points)

Draw a UML **class diagram** for the following problem domain: *"A UML class diagram consists of a number of classes. Each class has a number of attributes and operations. Classes also participate in relationships with others, for example through associations and generalizations."* Keep it **simple**: Focus on classes, generalizations, and associations (including multiplicities). Please **document** any further assumptions you make.

This page is intentionally **mostly** blank in case you run out of space elsewhere. If you ended up here early, please go over **everything** again and remain seated **quietly**! Make sure that the title page is filled out correctly and in **permanent** pen. Maybe you want to "rewrite" your **answers** in permanent pen as well?