Name: _____

CSE 303, Autumn 2006, Final Examination

12 December 2006

Please do not turn the page until everyone is ready.

Rules:

- The exam is closed-book, closed-note, except for one two-sided 8.5"x11" piece of paper.
- Please stop promptly at 4:20.
- You can rip apart the pages, but please write your name on each page.
- There are **79 points** total, distributed **unevenly** among 6 questions (many of which have multiple parts).
- When writing code, style matters, but don't worry about indentation.

Question	Max	Grade
1	11	
2	16	
3	10	
4	13	
5	9	
6	20	
Total	79	

Advice:

- Read questions carefully. Understand a question before you start writing.
- **Write down thoughts and intermediate steps so you can get partial credit.**
- The questions are not necessarily in order of difficulty. **Skip around.**
- If you have questions, ask.
- Relax. You are here to learn.

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1. (**11 Points**) Consider the following three header/source files:

```
--- bar.h ------------------------------------------------

struct Bar {
  int baz;
  int quux;
};

--- foo.h ------------------------------------------------

#include "bar.h"
int foo(struct Bar *bar);

--- foo.c ------------------------------------------------

#include <stdlib.h>
#include "foo.h"
#include "bar.h"

int main(int argc, char**argv) {
  struct Bar b = {atoi(argv[1]), atoi(argv[2])};
  return foo(&b);
}

int foo(struct Bar *bar) {
  return (bar->baz == bar->quux) ? 1 : 0;
}
```

(a) (2 pts) What error will you get when you compile with `gcc –Wall –o foo foo.c`?

(b) (2 pts) How can you change `foo.h` so that compilation will succeed? Be specific.

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Problem 1, continued

(c) (2 pts) How can you change `bar.h` so that compilation will succeed? Be specific.

(d) (2 pts) Is it best to fix this problem by changing `foo.h`, `bar.h`, or both? Why?

(e) (3 pts) What will happen when you run this program in the following ways? Give the code that is returned and/or describe any errors that occur.

- `./foo 1 1`
- `./foo 1 One`
- `./foo 1`

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2. (**16 Points**) Consider the following Class definitions. (Feel free to rip out this page.)

```
class A {

  char *str;

public:
  A(char *s) : str(s) {}

  ~A() {}

  char *getStr() { return str; }
};


class B {
  char *str;

public:
  B(char *s) {
    str = (char *)malloc(strlen(s) + 1);
    strcpy(str,s);
  }

  ~B() { free(str); }

  char *getStr() {
    char *newStr = (char *)malloc(strlen(str) + 1);
    strcpy(newStr,str);
    return newStr;
  }
};
```

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Problem 2, continued

(a) (2 pts) These two classes have the same data members and the same interface. Why is class `B` more robust?

(b) (2 pts) What information should be included in a minimum specification for `B::B(char *s)`?

(c) (2 pts) What information should be included in a minimum specification for `B::getStr()`?

(d) (2 pts) Write a line of code that you could add to the top of `B::B(char *s)` to make it more robust.

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Problem 2, continued

For each of the following code sequences, say what compile time or run time problems it causes, if any.

(e) (2 pts)

```
void f1() {
  A a("A");
  B b("B");
  b = (B)a;
}
```

(f) (2 pts)

```
void f2() {
  A *a = (A*)new B("B");
  delete a;
}
```

(g) (2 pts)

```
void f3() {
  A *a = dynamic_cast<A*>(new B("B"));
  delete a;
}
```

(h) (2 pts)

```
void f4() {
  B b1("B1"), b2("B2");
  b2 = b1;
}
```

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3. (**10 Points**) Consider the following code:

```
#include <iostream>

using namespace std;


class C1 {
  int _i1;

public:
  C1(int i1) : _i1(i1) {}

  virtual void PrintA(ostream &out) {
    out << _i1 << endl;
  }
  void PrintB(ostream &out) {
    out << _i1 << endl;
  }
};


class C2 : public C1 {
  int _i2;

public:
  C2(int i1, int i2) : C1(i1), _i2(i2) {}

  void PrintA(ostream &out) {
    out << _i2 << endl;
  }
  virtual void PrintB(ostream &out) {
    out << _i2 << endl;
  }
};


class C3 : public C2 {
  int _i3;

public:
  C3(int i1, int i2, int i3) : C2(i1,i2), _i3(i3) {}

  void PrintA(ostream &out) {
    out << _i3 << endl;
  }
  void PrintB(ostream &out) {
    out << _i3 << endl;
  }
};
```

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Problem 4 (continued)

For each commented line below, indicate what is printed on cout.

```
int main() {
  C1 c1(1);
  C2 c2(1,2);
  C3 c3(1,2,3);

  C1 *p1 = &c1;
  C1 *p2 = dynamic_cast<C1*>(&c2);
  C1 *p3 = dynamic_cast<C1*>(&c3);

  p1->PrintA(cout);   // Output is _________

  p1->PrintB(cout);   // Output is _________

  p2->PrintA(cout);   // Output is _________

  p2->PrintB(cout);   // Output is _________

  p3->PrintA(cout);   // Output is _________

  p3->PrintB(cout);   // Output is _________


  C1 c1_2 = c2;
  C1 c1_3 = c3;


  c1_2.PrintA(cout);   // Output is _________

  c1_2.PrintB(cout);   // Output is _________

  c1_3.PrintA(cout);   // Output is _________

  c1_3.PrintB(cout);   // Output is _________

}
```

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4. (**13 Points**) The following is a list of files and the include statements found in each:

```
-- Pilot.h --------------------------------
#include <iostream>

-- Pilot.cpp ------------------------------
#include "Pilot.h"

-- Viper.h --------------------------------
#include <iostream>

-- Viper.cpp ------------------------------
#include <cassert>
#include "Viper.h"
#include "Battlestar.h"
#include "Pilot.h"

-- Battlestar.h ---------------------------
#include <iostream>
#include <string>
#include <vector>

-- Battlestar.cpp -------------------------
#include <cassert>
#include "Battlestar.h"
#include "Viper.h"

-- main.cpp -------------------------------
#include <iostream>
#include <iostream>
#include "Battlestar.h"
#include "Viper.h"
```

Suppose we also have a `Makefile` that begins with the following lines.

```
-- Makefile -------------------------------

GXX = g++
CFLAGS = -Wall –g
```

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Instead of using static libraries, we want this `Makefile` to compile `main.cpp`, `Battlestar.cpp`, `Viper.cpp`, and `Pilot.cpp` and link them to create a program called `bsgsim`. Indicate whether or not the following lines of the Makefile are correct. If they are incorrect, write the corrected version.

(a) (3pts)

```
Battlestar.o: Battlestar.cpp Battlestar.h Viper.h
      g++ -Wall -g -c -o $@ $<
```

(b) (3pts)

```
Pilot.cpp: Pilot.h
      g++ -Wall -g -c –o Pilot.o $<
```

(c) (3pts)

```
bsgsim: main.o Viper.o Battlestar.o
      $(GXX) $(CFLAGS) -o $@ $<
```

For each statement below, indicate whether it is true or false.

(d) (1 pt) In order for the whole project to compile when we type "`make`", the line that builds "`bsgsim`" should go at the bottom of the `Makefile`.

True False

(e) (1 pt) In order to run `bsgsim` in `gdb`, we would have to add a special flag to each `Makefile` command above.

True False

(f) (1 pt) In order to profile `bsgsim` with `gprof`, we would have to add a special flag to each `Makefile` command above.

True False

(g) (1 pt) Suppose `Battlestar.o, Viper.o`, and `Pilot.o` were each placed in static libraries (`libB.a`, `libV.a`, and `libP.a`). If we link them to `bsgsim` with the flags `-lP -lB –lV -lB -lV`, (in that order) we are guaranteed success.

True False

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5. (**9 Points**) The project in the previous problem has been imported into a Subversion repository. Bob and Kate both have working copies of this project. All files in the repository and in both of their working copies are at revision 1. Both Bob and Kate begin to edit the file `Pilot.cpp`. After each command executed by Bob or Kate below, indicate the revision of `Pilot.cpp` that appears in the repository, Bob's working copy, and Kate's working copy. If the revision has no number, write the letter "e" (for "edited") in the blank. You may assume that no other commands are executed.

	Repository	Bob's	Kate's
(a) (2 pts) Bob makes edits and executes this command: `svn commit Pilot.cpp -m "Bob"`	_____	_____	_____
(b) (2 pts) Kate makes edits and executes this command: `svn revert Pilot.cpp`	_____	_____	_____
(c) (2 pts) Kate makes edits and executes this command: `svn commit Pilot.cpp -m "Kate"`	_____	_____	_____
(d) (2 pts) Kate executes this command: `svn update Pilot.cpp`	_____	_____	_____

(e) (1 pt) Assuming Kate makes no edits to other files in the project, what is the revision of these other files after the above commands are executed?

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6. (**20 Points**) Consider the following code snippets contained in the files indicated. (Feel free to rip out this page.)

```
-- Viper.h -----------------------------

class Viper {
  Battlestar *base;
  int id;
public:
  Viper(int i, Battlestar *b=NULL);
  void Land(Battlestar &b);
  void Launch();
  const Battlestar * GetBattlestar() const;
};

-- Battlestar.h ------------------------

class Battlestar {
  string name;
  vector<Viper*> inside;
public:
  Battlestar(string n, int nVipers=10);
  Viper *GrantLaunchClearance(Viper *v);
  void GrantLandingClearance(Viper *v);
  bool ViperInside(Viper *v) const;
  const string &GetName() const;
};

-- Battlestar.cpp ----------------------

// Lands the Viper v on this Battlestar.
// Precondition: v Cannot be in this Battlestar's list
// Precondition: v's Battlestar must be NULL
void Battlestar::GrantLandingClearance(Viper *v) {
  assert(!ViperInside(v) && v->GetBattlestar() == NULL);
  v->Land(*this);
  inside.push_back(v);
}

// Returns true if the Viper is inside this Battlestar.
// Otherwise, returns false.
bool Battlestar::ViperInside(Viper *v) {
  for (unsigned int i=0; i<inside.size(); i++) {
      if (inside[i] == v)
      return true;
  }
  return false;
}
```

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Problem 6, continued:

(a) (6 pts) Given the code above and the code sequence below, indicate whether or not the commented lines below would produce errors when compiled. You may assume that all the necessary headers have been included. (Indicate your choice by writing "Yes" or "No" after each "`// Error?`" comment.)

```
Viper v1 = 1;                                   // Error?
Viper v2(2);
Battlestar g("Galactica");

Battlestar *b1 = v1.GetBattlestar();            // Error?

const Battlestar *b2 = v1.GetBattlestar();      // Error?

cout << v1.GetBattlestar()->GetName();          // Error?

v1.GetBattlestar()->GrantLaunchClearance(&v1);//Error?

v2.Land(*b2);                                   // Error?
```

(b) (3 pts) Which of the following make good "black box" tests for the method `Battlestar::GrantLandingClearance`? Circle all that apply.

1. A code sequence that checks the effects of the method against the specification.
2. A code sequence that exercises every function call inside the method.
3. A code sequence that violates the method's preconditions.

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(c) (5 pts) Suppose that you compile and run the project `bsgsim` with no arguments, after which you discover that `Battlestar::GrantLandingClearance` is failing an assertion. How would you use `gdb` to determine which precondition was violated and which caller violated it? You must give either specific commands or clear descriptions of each step.

(d) (3 pts) After getting `bsgsim` to work, you start to think that it is running too slowly. You start to profile it using `gprof`. You suspect that the method `Battlestar::ViperInside` is too slow and that you need to implement a faster algorithm. You profile it, check the flat profile, and notice that this method is called 100 times more than any other. Does this give you a clear sense of whether or not you should rewrite this method? Explain your answer.

(e) (3 pts) Continuing your investigation of `Battlestar::ViperInside`, you notice that whenever you run the program, about 80% of the time is spent in this method, and it is called only from `Battlestar::GrantLandingClearance`. Does this give you a clear sense of whether or not you should rewrite the method? Explain your answer.