CMSC 202 Final **May 19, 2005**

Name: ______________________________ **UserID:** __________________

(Circle your section)

Section: **101** – Tuesday 11:30 **102** – Thursday 11:30

103 – Tuesday 12:30 **104** – Thursday 12:30

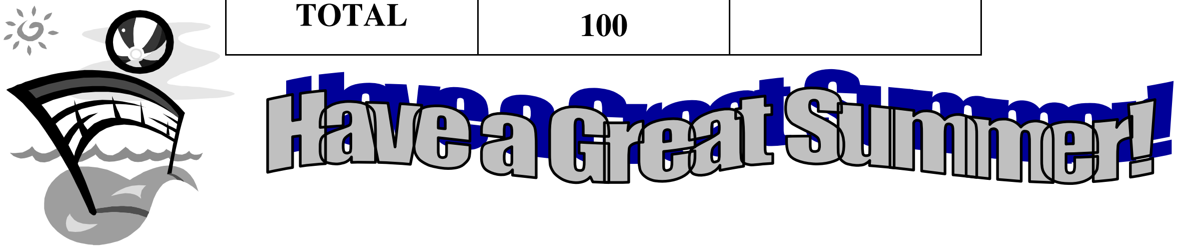
105 – Tuesday 1:30 **106** – Thursday 1:30

Directions

- This is a closed-book, closed-note, closed-neighbor exam.
- Read through the entire test before you begin.
- Start with the questions that are easiest for you, come back to the rest.
- Write CLEARLY, if I cannot read your writing, you will receive a zero for the problem in question.
- Feel free to continue your answer on the backs of the pages, but make sure that you indicate where your answer continues.
- When you are done, read over your answers and then bring your exam to the front of the room.
- **You will need your Picture ID to hand in your exam.**

Score

Page Number	Points Possible	Points Earned
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
TOTAL	**100**	



Section 1: True/False (10 pts total, 1 pt each)

Read each statement ***carefully*** and write **true** or **false** on the blank to the left.

____________ 1. An abstract class has one or more virtual functions.

____________ 2. A class that is intended to be a base class need not have a virtual destructor.

____________ 3. A derived class has direct access to the base class's private data members

____________ 4. An inline function guarantees that a compiler will replace the function call with the body of the function.

____________ 5. When using exceptions, only one try block is allowed per program while many catch blocks are allowed.

____________ 6. The following is a valid collection of elements of a Set<int> object from the STL: {2, 4, 3, 4, 6, 3, 2, 1, 5}

____________ 7. Templated classes and functions are generated and bound at compile-time.

____________ 8. Assume there is a class named B that inherits privately from A, and a class C that inherits publicly from B, the following object instantiation is acceptable:
C* ptr = new A;

____________ 9. Static binding describes the ability of the compiler to bind an object to the correct method in an inheritance hierarchy.

____________ 10. Assume there is a class named B that inherits publicly from A, where A is an abstract class, the following object instantiations are acceptable:
A* a = new A();
B* b = new B();
A* c = new B();

Short Answer

Complete each of the short-answer coding questions. You may assume that the questions build on each other and that previously implemented lines can be used in later questions.

Assume there is a class named Ball with derived classes named BeachBall, FootBall, and VolleyBall.

11. (4 pts) Define a **vector** of **Ball pointers**.
    Define an **iterator** to this vector.

12. (2 pts) Assume there are already 4 Balls (of various subtypes) in the vector.
    Add a **BeachBall** to the vector.

13. (4 pts) Assume that the **insertion** operator is **overloaded** for all **Ball** types.
    Using a **for-loop** and the **iterator**, iterate through the vector, **printing** each ball to the screen.

14. (10 pts) Assume that the **< (less than) operator** is defined for all Ball types and returns a **boolean** (true=current object is less). Define a **templated** function that finds the **Smallest** item in the vector and **returns its index**.

_______ pts

15. (15 pts) Assume that the following **operators** are **defined** for all STL **iterators**: <, >, <=, >=, ==, !=, ++, and --. Using one or more of these operators, **overload** the **subtraction** operator for the List iterator that will subtract one iterator from another, **returning** an **integer** representing the number of items between them. Do not overload the operator as a class method.
Ex: If there are 5 items in a vector, then vec.end() – vec.begin() should return 5.

16. (5 pts) Assume the **BeachBall** has an overloaded **constructor** that accepts a **radius**. Assume there is also a **related mutator**. Assume the following lines are defined:

```
     BeachBall a(7.0);
     BeachBall b(6.0);
     const BeachBall c(5.0);
     const BeachBall* p = &a;
     BeachBall* const q = &b;
```

Identify whether the following lines are **illegal**, if so, describe **why**.

```
p->SetRadius(1.0);
```

```
q->SetRadius(2.0);
```

```
p = &c;
```

```
q = &c;
```

```
p->SetRadius(1.0);
```

```
q->SetRadius(2.0);
```

17. (10 pts) Assume that the BeachBall **constructor** used in the previous question **throws** a **NegativeException** and an **unknown exception**. Write the **try/catch** block that will create a BeachBall and correctly **catch** the exceptions. Assume there is a message() method that returns the exception's message if necessary.

18. (10 pts) Assume the BeachBall has a **dynamic** member of type **pointer to string** called m_name and a double called m_radius. Assume the constructor accepts values for both as parameters. Implement the **constructor** that **throws** a **NegativeException** if the **radius** parameter is **less than zero**.

19. (5 pts) Implement the **destructor** for the BeachBall class, assume it has been prototyped in the class definition.

20. (5 pts) **Free** all the memory used by the **vector**.

_______ pts

Class Implementations

21. (15 pts) Write the **class definition** (header file) for the Ball class. Use constants, virtual and references whenever appropriate. The Ball class has the following members:
    a. **radius** data member, double – inherited classes should have access
    b. **Default** constructor, sets radius to zero
    c. **Non-default** constructor, sets radius to parameter value if valid
    d. **Copy** constructor
    e. **Destructor** – destroys object
    f. **Inflate** method – increases radius by 0.1
    g. **Deflate** method – decreases radius by 0.1, if possible
    h. **Volume** method – possibly overridden by inherited classes, calculates and returns volume of Ball
    i. **Print** method – must be overridden by inherited classes

22. (15 pts) Write the **class definition** (header file) for the BeachBall class. Use constants, virtual and references whenever appropriate. The BeachBall class has the following members:
    a. (10 pts) **BeachBall**, inherits from **Ball**
        i. **name** data member, pointer to a string
        ii. **Default** constructor
        iii. **Non-default** constructor, uses non-default constructor of Ball
        iv. **Copy** constructor, uses copy constructor of Ball
        v. **Destructor** – destroys any dynamic memory
        vi. **Print** method – overrides Ball's version

    b. (5 pts) Implement **two** versions of the **Copy** constructor (shallow and deep)
        i. **Shallow** Copy

        ii. **Deep** Copy

23. (10 pts) Write the definition for a templated collection class called **Bin**. Use constant and reference as appropriate. Bins have the following members:
    a. **items** data member – dynamic structure to hold collection of items
    b. **Default** Constructor
    c. **AddItem** method – add item (parameter) at "end" of collection
    d. **RemoveItem** method – removes item at "beginning" of collection, returns that item
    e. **overloaded [] operator** (array access) – accepts an integer i, returns the ith item in the collection

24. (5 pts) Implement **AddItem**

25. (5 pts) Implement **RemoveItem**

26. (5 pts) Implement the **overloaded [] operator**

_______ pts

Exposition

27. (5 pts) **Why** do we want to allow **derived** classes to **override** the **Volume** method of the Ball class? Provide an **example** to support your answer.

28. (5 pts) What method is **missing** from both the **Ball** and **BeachBall** class? **Why** must we **include** this method?

29. (5 pts) **Briefly describe** the process of "**stack unwinding**" which occurs if an exception is not caught.

30. (10 pts) Briefly describe the generally accepted **classifications** of **exception safety** that a function can make?

_______ pts

Extra Credit

1. (5 pts) Assume that you want to implement a templated Queue (FIFO – first in, first out), but only have access to a Stack (LIFO – last in, first out) with the following methods:
    - `push`, pushes an item onto the stack.
    - `pop`, pops an item from the stack but does not give this item to the programmer to use.
    - `top`, gives the programmer a reference to the top of stack item; no change is made to the stack.
    - `empty`, the usual boolean function (true = stack is empty).
    - `size`, reports the number of items on the stack.

    Describe briefly how you would **use** a **Stack** to **implement** a **Queue**.
    Draw a **picture** to clarify your strategy.
    You may assume that your Queue class supports the following:
    - private data member: `Stack<T> stack;`
    - `insert` method – insert the parameter into the "end" of the Queue
    - `remove` method – remove the "first" item from the Queue and return that item

2. (10 pts) **Implement** the **insert**() and **remove**() methods for your Queue using the STL stack. You may allocate any additional memory necessary, but cannot use any other data structure other than Stack.

Extra Credit – Part Deux

3. (5 pts) Define a **function object** called **Mystery** that will accept an **integer** by **reference**, **multiply** it by **2** and then **add** the value of the private **data member** (set via the constructor). Declare all methods **inline**.

4. (5 pts) Use this Mystery function with the **for_each** function on a vector of integers (you can assume the code below). Use **7** as the parameter to the **Mystery** constructor.

```
vector<int> vec;
vec.push_back(1);
vec.push_back(2);
// … other values are added…
```

5. (2 pts) If you could have any **ONE superpower** (fly, x-ray vision, super strength, speed, time-travel, etc.), **what power** would you have and **why**? Creative answers will get credit.