CS 202 - Computer Science II

Final Sample

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Test Objectives: A comprehensive evaluation of the course material. Everywhere, the use of pointers, bracket-notation, and the built-in C-string library <string.h> functions are allowed.

Program 1 (60 pts):
You are given the working definitions and implementations of two Classes (description-only shown here):

```
class Cover{
  public:
    //Cover() default constructor, sets m_hard to false
    //Cover(bool hard) parametrized constructor, sets m_hard to hard
  //operator<< overload, outputs m_hard to the calling object(cout,etc…)
  //operator>> overload, assigns m_hard a 0/1 value from calling object input(cin,etc…)
    //GetValue() method, returns m_hard by value and does not modify calling object
  private:
    bool m_hard;
};
```

```
class Client{
  public:
    //Client() default constructor, leaves m_name uninitialized
    //Client(const char* name) parametrized constructor, copies c-string name to m_name
    //Client(const Client& other) copy constructor, deep-copies data
    //~Client() destructor, deallocates memory as necessary
    //operator= overload, deep-copies data and returns reference to calling object
//operator<< overload, outputs m_name to the calling object(cout,etc…)
//operator>> overload, grabs and copies to m_name input from calling object(cin,etc…)
    //GetName() method, returns m_name by address and does not modify calling object
  private:
     char* m_name;
};
```

(Part1 Grading Scheme: **20pts, 10pts Class Declaration – 10pts Class Implementation**)
(Hint: A smaller subset of such specifications will be required for the actual Finals)
For the first part of this program you are required to implement a Book class, which will has to adhere by these specifications:

Each Book should have the members (all private):

- **m_title**: a C-string (pointer-not array) representing the book title.
- **m_cover**: a Cover class object which represents the book cover.
- **m_client**: a Client class const pointer, the person (renter) who currently has the book in their possession. If the book is not rented out to someone this pointer should be NULL. (Hint: Remember const pointer means the m_client variable can be assigned to pointed to different objects, but it cannot be used to modify the object it points to).
- **m_serial**: a constant size_t number, representing a unique identifier for each Book object.

and the Book class will also have a (private as well):

- **count**: a static size_t, keeping track of the last (greatest) unique Book id (as generated via a constructor).

and for the Book ADT you are required to implement:

- a **Default Constructor**.
- a **Parametrized Constructor**, with a parameters list that allows initialization of all members. The order should be: (m_name, m_cover, m_client, m_serial) and there should be default parameters in the list passed for m_cover, m_client, and m_serial.
- a **Copy Constructor**. It should deep-copy the Book Object's members, except m_client (the new Book will have no renter). Also, a new unique m_serial should be assigned.
- an **Assignment operator=** overload. It should deep-copy the Book Object's members that it can, and shallow-copy m_client (the new Book will have the exact same renter). Returns a reference to the calling object.
- **get/set** methods for **m_cover** and **m_client**. Get methods should not allow modification of the calling object.
- **get** methods for **m_title** and **m_serial**, which should not allow modification of the calling object.
- a **serialize** method. It should output the Book's: m_title, m_cover, m_serial, and m_client (if a renter exists).
- an **Insertion operator <<** overload. It should use the serialize method of the passed Book object to output its data to the std::ostream object it takes as its first parameter.

```cpp
#include <iostream>
#include <string.h>
using namespace std;

//fill with return values, parameters, specifiers
class Book {
  public:
  //default ctor
  Book(                                                    )       ;

  //parametrized ctor
  Book(

                                                           )       ;

  //copy ctor
  Book(                                                    )       ;

  //dtor
  ~Book(                                                   )       ;

  //assignment operator
                        operator=(                         )       ;

  //get set methods
                         getCover(                         )       ;

                         setCover(                         )       ;

                        getClient(                         )       ;

                        setClient(                         )       ;

  //serialize method

                        serialize(                         )       ;

  //insertion operator overload
                        operator<<(

                                                           )       ;

  //data members
  private:









};
```

```
//default ctor
Book::Book(                                                    )


{


}

//parametrized ctor
Book::Book(                                                    )


{


}


//copy ctor
Book::Book(                                                    )


{


}


//dtor
Book::~Book(                                                    )


{


}


//assignment operator
                    Book::operator=(                           )
{


}
```

```
//get set methods
                    Book::getCover(                                    )
{


}
                    Book::setCover(                                    )
{


}
                    Book::getClient(                                   )
{


}
                    Book::setClient(                                   )
{


}

//serialize method
                    Book::serialize(                                   )
{


}


//insertion operator overload
                      operator<<(

                                                                       )
{


}
```

(Part2 Grading Scheme: **20pts, 10pts Class Declaration – 10pts Class Implementation**)
(Hint: A subset of such specifications will be required for the actual Finals)
For the second part of this program, you are required to implement a ChildrenBook class, which has to adhere by these specifications:

Each ChildrenBook should be a Derived class inheriting from the Book Base class.

- Rewrite only the members section of the Book base class declaration, so that ChildrenBook has Inheritance-level access to: m_title, m_cover, m_serial.

Each ChildrenBook object will have its own private member:

- **m_graphic**: a bool representing whether it's a graphic or literature novel.

and for the ChildrenBook derived ADT you are required to implement:

- a **Default Constructor**.
- a **Parametrized Constructor**, with a parameters list that allows initialization of all members of the base class, as well as a bool graphic parameter that is used to initialize m_graphic. The order should be: (m_name, m_graphic, m_cover, m_client, m_serial) and there should be default parameters in the list passed for m_cover, m_client, and m_serial.
- a **Copy Constructor**. It should perform the exact same operations as the Book base class one. Additionally, m_graphic should be copied to the new ChildrenBook.
- an **Assignment operator=** overload. It should perform the exact same operations as the Book base class one. Additionally, m_graphic should assigned to the calling ChildrenBook.
- **get/set** methods for **m_graphic**. The Get method should not allow modification of the calling object.
- a **serialize** method. It should output the ChildrenBook's: m_title, m_graphic, m_cover, m_serial, and m_client (if a renter exists). Notice that it also outputs m_graphic which is the Derived class extra member.
- an **Insertion operator <<** overload. It should use the serialize method of the passed ChildrenBook object to output its data to the std::ostream object it takes as its first parameter.

```
#include <iostream>
#include <string.h>
using namespace std;

//rewrite Book to grant some inheritance level access to ChildrenBook
class Book {
  …
  //rewrite only the changed access specification items




};

//possible ChildrenBook derived class globals, etc.



//fill derived class with return values, parameters, specifiers
class ChildrenBook                                          {
  public:
  //default ctor
  ChildrenBook(                                                          )       ;

  //parametrized ctor
  ChildrenBook(                                                          )       ;

  //copy ctor
  ChildrenBook(                                                          )       ;

  //dtor
  ~ChildrenBook(                                                         )       ;

  //assignment operator
                        operator=(                                       )       ;

  //get set methods
                       getGraphic(                                       )       ;

                       setGraphic(                                       )       ;

  //serialize method
                        serialize(                                       )       ;

  //insertion operator overload
                       operator<<(
                                                                         )       ;

  //data members
  private:



};
```

```
//default ctor
ChildrenBook:: ChildrenBook(                                        )


{


}

//parametrized ctor
ChildrenBook:: ChildrenBook(                                        )


{


}


//copy ctor
ChildrenBook:: ChildrenBook(                                       )


{


}


//dtor
ChildrenBook::~ChildrenBook(                                       )


{


}


//assignment operator
                ChildrenBook::operator=(                          )
{


}
```

```
//get set methods
              ChildrenBook::getGraphic(                          )
{



}

              ChildrenBook::setGraphic(                          )
{



}

//serialize method
              ChildrenBook::serialize(                          )
{



}

//insertion operator overload
                    operator<<(

                                                                   )
{



}
```

(Part3 Grading Sheme: **20pts, 5pts-per-Question**)
For the second part of this program, you are required to consider the following main():

```
001 #include <iostream>
002 #include <string.h>
003
004 #include "Cover.h"
005 #include "Client.h"
006 #include "Book.h"
007 #include "ChildrenBook.h"
008
009 using namespace std;
010
011 int main()
012 {
013    Client jDoe("John Doe");
014    Book myBook("LOTR ROTC", Cover(true), &jDoe, 999);
015
016    Client jDoeJr("John Doe Jr");
017    ChildrenBook myChildBook("LOTR comic", true, Cover(false), &jDoeJr);
018
019    Book * book_Pt;
020
021    book_Pt = &myBook;
022    cout << *book_Pt << endl;
023
024    book_Pt = &myChildBook;
025    cout << *book_Pt << endl;
026
027    return 0;
028 }
```

- What is the output of lines 022 and 025 (briefly mention for each whether they output just the Base or the Derived class information too)?
- Explain what the problem is, when trying to access the Derived class information through a Base class pointer. Pointer Book "of"
- How would you propose to fix the aforementioned problem (you are only allowed to modify class declarations and/or implementations, not add any more functions)? Briefly mention the modifications you would make. make Serialize virtual
- What is now the output of highlighted lines 022 and 025 (briefly explain why)?

Base class pointer can access derived class

Program 2 (15 pts):
You are given a class Declaration for a Matrix class, which relies on dynamic memory for storage.

```
001 class DynamicMatrix {
002  public:
003   // 1) instatiates a [0]x[0] NULL matrix
004   DynamicMatrix();
005   // 2) instatiates a [rows]x[cols] matrix with all elements set to
006 [value]
007   DynamicMatrix(int rows,int cols, int value=0);
008   // 3) instantiates via matrix copy
009   DynamicMatrix(const DynamicMatrix & otherDynamicMatrix);
010   // 4) destroys matrix and deallocates dynamic memory
011   ~DynamicMatrix();
012
013   // 5) assignment operator
014   DynamicMatrix & operator=(const DynamicMatrix & other);
015
016   // …
017
018  private:
019   int m_rows;
020   int m_cols;
021   int ** m_matrix;
022 };
```

(Hint: Question variants on this can include any Method)
Give the implementation of its Copy Constructor (#3).

Lab 9

copy ctor

- new int pointer array
- two for loops

m_matrix = new int*[m_rows]

for(i=0; i<rows; i++)

- create int pointer array

m_matrix[i] = new int[m_cols]

for(j=0; j<cols; j++)

- fill data

m_matrix[i][j] = other.m_matrix[i][j]

Dtor

for(rows)

delete[] m_matrix[i]

delete[] m_matrix

Program 3 (15pts, 2.5 pts Node Declaration – 2.5 pts Node Implementation – 5pts Queue Declaration – 5pts Queue Implementation):
You are given a class Declaration for a (Node) Queue class that works with int objects. You have to provide:

- a) The templated version of class Node (declaration and implementation). Hint: Also write any possible necessary forward declarations.
- b) The templated version of class Queue (declaration, including any necessary forward declarations).
- c) The templated (non-templated will receive partial credit) implementation of the Queue methods: push(), pop(), size(), clear(), serialize() and the overloaded insertion operator<<. **(Hint: Question variants on this can include any Method).**

```
001 ////////////////////////////NODE//////////////////////////////////
002 class Node{
003 public:
004   Node() : m_next(NULL){ }
005   Node(const int & data, Node * next = NULL) : m_data(data),
006 m_next(next){ }
007   const int & getData() const{ return m_data; }
008   int & getData(){ return m_data; }
009 friend class Queue;  //declaration of friend class
010 private:
011   Node * m_next;
012   int m_data;
013 };
014
015 ////////////////////////////QUEUE//////////////////////////////
016 class Queue{
017 friend std::ostream & operator<<(std::ostream & os,
018                                  const Queue & queue);
019 public:
020   Queue();
021   ~Queue();
022   Queue & operator=(const Queue & other);
023   const int & front() const;
024   int & front();
025   const int & back() const;
026   int & back();
027   void push(const int & value);
028   void pop();
029   size_t size() const;
030   void clear();
031   void serialize(std::ostream & os) const;
032 private:
033   Node * m_front;
034   Node * m_back;
};
```

op4
Node<T> * curr,
Node<T> * curr2 = m_front,
m_front = new Node<T>(getData)
curr = m_front,
for (curr2 != NULL ...

int → T

forwards
template<class T> class Queue,
template<class T>
std::ostream & operator<<(std::ostream & os, const Queue & q)

Question 1 (5 pts): (Subject: Class Relationships and Operations, you have to follow the program flow by starting at the main function entry point and tracing all the calls (constructors, operators, etc) made subsequently)

What is the expected output of this C++ program?

```
001 #include <iostream>
002 #include <string.h>
003
004 using namespace std;
005
006 class Base{
007   public:
008     Base(){ cout << "B" << ++count << endl; }
009     ~Base(){ cout << "~B" << --count << endl; }
010   protected:
011     static size_t count;
012 };
013 size_t Base::count = 0;
014
015 class Derived : public Base{
016   public:
017     Derived(){ cout << "D" << ++d_count << "," << count << endl; }
018       ~Derived(){ cout << "~D" << --d_count << "," << count << endl; }
019   private:
020     static size_t d_count;
021 };
022 size_t Derived::d_count = 0;
023
024 void fB(){
025       Base b;
026 }
027 void fD(){
028       Derived d;
029 }
030
031 int main()
032 {
033   fB();

     fD();

     return 0;
}
```

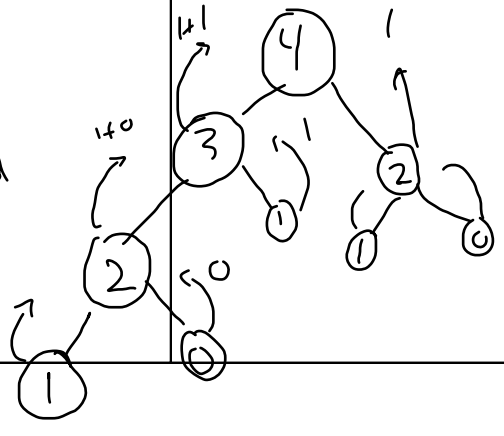
Question 2 (5 pts): (Subject: Recursive Functions, you have to learn the examples of recursion given in Lecture 25, and/or potentially identify the case of an Infinite Recursion)
Will these programs work? If yes, what is the expected output?

```
001 #include <iostream>
002 #include <string.h>
003
004 using namespace std;
005
006 void rec (int n){
007   if (n < 0){
008     cout << n << endl;
009   }
010   else {
011       rec( n / 10 );
012       cout << ( n % 10 ) << endl;
013   }
014 }
015
016
017 int main()
018 {
019   rec(123);
020
021   return 0;
022 }
023
024
025
026
027
028
029
030
031
032
033
```

n=123
12
1
0
0
6

Will not work as intended

```
#include <iostream>
#include <string.h>

using namespace std;

int rec (int n) {
  cout << n << " ";
  if (n > 1)
    return rec (n-1) + rec (n-2);
  else
    return n;
}

int main()
{
  int r = rec(4);

  cout << endl << r;

  return 0;
}
```



Out
4 3 2 1 0 1 2 1 0

Question 3 (5 pts): (Subject: Working/Compiling with Templates, you have to apply the rules you have learnt on how to compile templated classes/functions and identify possible compilation errors (e.g. (i) missing forward declaration of Templated class before the forward declaration of a Templated operator overload for this class' objects, (ii) missing empty angled brackets <> in friend templated method declaration unless the method is inlined, etc.) or if compilation goes through, trace the program output from the resulting Templated implementation).

Will this program compile? Briefly mention what it will do if yes.

```
001 #include <iostream>
002 #include <string.h>
003
004 using namespace std;
005
006 template<class T, size_t NROWS, size_t NCOLS>
007 std::ostream & operator<<(std::ostream & os,
008                           const Matrix<T,NROWS,NCOLS> & matrix);
009
010
011 template<class T, size_t NROWS=1, size_t NCOLS=1>
012 class Matrix{
013  public:
014   Matrix(){}
015
016  friend std::ostream &  operator<< <> (std::ostream & os,
017                                        const Matrix<T,NROWS,NCOLS> & matrix);
018
019  private:
020   T container[NROWS][NCOLS];
021 };
022
023
024 template<class T, size_t NROWS, size_t NCOLS>
025 std::ostream &operator<<(std::ostream & os,
026                          const Matrix<T,NROWS,NCOLS> & matrix)
027 {
028   for (size_t i=0; i<NROWS; ++i){
029     for (size_t j=0; j<NCOLS; ++j){
030       os  <<  matrix.container[i][j] << " ";
031       }
032       os << std::endl;
033   }
034   os << std::endl;
035
036 }
037
038 int main()
039 {
040   Matrix<float, 10, 5> mat;
041   cout << mat;
042
043   return 0;
044 }
```

Forward Declaration

Question 4 (5 pts): (Subject: Stack Unwinding / Exception Classes / throw-catch, you have to trace the process of Stack Unwinding)

What is the expected output here?

```
001 #include <iostream>
002 #include <string.h>
003
004 using namespace std;
005
006 class MyException{
007  public:
008     // instantiates and initializes info string
009     MyException(const char * s) : m_info(s){ }
010     // sets info string to desired value
011     void setInfo(const char * s){ m_info = s; }
012   // handles output of exception object data (info string)
013   friend std::ostream & operator<<(std::ostream & os,
014                                    const MyException & e){
015       os << e.m_info;
016       return os;
017  }
018  private:
019     std::string m_info;
020 };
021
022 class A{
023   public:
024     A(){ cout << "A" << endl; }
025     ~A(){ cout << "~A" << endl; }
026 };
027
028 int main(){
029
030   try{
031     A anA;
032
033     try{
034       A anotherA;
035
036       //error detected
037       throw MyException("Something awful happened here...");
038     }
039     catch(MyException & e){
040         cerr << e << endl;
041         e.setInfo( "It's been taken care of!" );
042         throw;
043     }
044   }
045   catch(const MyException & e){
046     cerr << e << endl;
047   }
048
049   return 0;
050 }
```