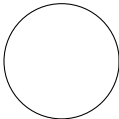
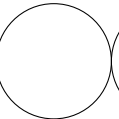
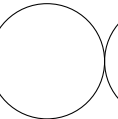
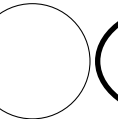


\$Id: cmips109-2015q1-exam3.mm,v 1.90 2015-03-18 18:00:14-07 - - \$

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						Name :
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Code only in C++11. No books ; No calculator ; No computer ; No email ; No internet ; No notes ; No phone. Neatness counts ! Do your scratch work elsewhere and enter only your final answer into the spaces provided.

1. Write the prototypes as they would appear inside the class `foo` declarations for the four implicitly generated members in C++98, and for the two others that appeared only in C++11. **[2✓]**

<pre>class foo { // both C++98 and C++11 public: };</pre>	<pre>class foo { // C++11 but not C++98 public: };</pre>
------------------------------------------------------------	-----------------------------------------------------------

2. Write the function `blue_triangle`, which has no parameters, which will draw a blue triangle with vertices at (0,0), (4,0), and (4,4). **[3✓]**

3. Define the template function `copy`. It has two template arguments, both forward iterator types. It has four function arguments: begin and end iterators bounding an input sequence, followed by begin and end iterators bounding an output sequence. It copies the input sequence to the output sequence. Assume that the output sequence is large enough. **[2✓]**

4. Write a function `zipwith`. It has two template parameters: an arbitrary element type, and a binary function type. It has three actual parameters: two vectors of the element type, passed in by constant reference, and a pointer to a binary function. Its result is a vector of the element type. Elements of the argument types are combined pairwise with the binary function to produce the output function. Throw a `domain_error` if the vectors have different lengths. For example,
- ```
vector<int> v1{1,2,3}, v2{4,5,6}, v3;
v3 = zipwith (v1, v2, plus<int>());
```
- will set `v3` to `{5,7,9}`. **[3✓]**

- 
5. Define the template class `queue` as it might appear in a header file. All functions must be declared inline inside the class definition. All of the implicitly generated members are acceptable and therefore do not need to be declared. It has a single private member of type `deque`, on which the queue is implemented. Define the following public members with appropriate signatures: `clear`, `size`, `empty`, `push_back`, `pop_front`, and `front`. Each of them simply uses the equivalent `deque` operation. [4✓]
6. Define three classes :
- (a) The base class is `shape`. It has a single protected constructor of no arguments, and two parameterless abstract functions `circumference` and `area` which return a `double`. For the mathematically challenged, remember that  $A = \pi r^2$  and  $C = 2\pi r$ . The header `<cmath>` defines the constant `M_PI`. [2✓]
  - (b) Class `circle` inherits from `shape` and has a private field `radius`. It has one constructor which takes a radius argument and overrides `circumference` and `area`. [2✓]
  - (c) Class `square` inherits from `shape` and has a private field `length`, which is the length of one edge. It overrides `circumference` and `area`. [2✓]

7. Write a function `differentiate` which performs symbolic differentiation on a polynomial. For example,

$$\frac{d}{dx} ax^3 + bx^2 + cx + d = 3ax^2 + 2bx + c$$

In other words, for each term in the sum of the form  $kx^n$ , the resulting derivative term is  $knx^{n-1}$ . Represent the polynomial as `using polynomial = vector<double>;`, with the exponent as the subscript and the coefficient as the value. So, for example,  $v = 5x^3 + 9x^2 + 8x + 10$  and its derivative  $d = 15x^2 + 18x + 8$  are represented as `polynomial v {10, 8, 9, 5};` and `polynomial d {8, 18, 15};`, respectively. **[3✓]**

```
polynomial differentiate (const polynomial& p) {
```

8. Finish the function which will draw a blue circle with radius 1, centered at coordinates (0,0). using OpenGL. When stepping around the circle it uses angle  $\Delta = 2\pi/32$ . **[3✓]**

```
void draw_circle() {
 constexpr double delta = 2 * M_PI / 32;
 glBegin (GL_POLYGON);
```

```
 glEnd();
}
```

9. Define a template function `print`, which takes a pair of iterators and an `ostream` and prints all elements within the range, preceded by an open brace (`{`) and followed by a close brace (`}`) with each element separated by commas. For example, `print (v.begin(), v.end(), cout);` might print `{3,4,5}`. **[2✓]**

10. Given the structure shown here, representing an expression tree where interior nodes are operators and leaf nodes are variables, finish the function `print` which will print out the entire tree in reverse Polish notation (a postorder traversal). **[2✓]**

```
struct tree {
 virtual void print (ostream& out) = 0;
};
struct leaf: public tree {
 char var;
 virtual void print (ostream& out) override {

 }
};
```

```
struct interior: public tree {
 char oper;
 tree* left;
 tree* right;
 virtual void print (ostream& out) override {

 }
};
```

Multiple choice. To the *left* of each question, write the letter that indicates your answer. Write **Z** if you don't want to risk a wrong answer. Wrong answers are worth negative points. **[12✓]**

|                                      |    |                        |       |
|--------------------------------------|----|------------------------|-------|
| number of correct answers            |    | $\times 1 =$           | $= a$ |
| number of wrong answers              |    | $\times \frac{1}{2} =$ | $= b$ |
| number of missing answers            |    | $\times 0 =$           | 0     |
| column total<br>$c = \max(a - b, 0)$ | 12 |                        | $= c$ |

- In the `listmap` project, if there are  $n$  integers in a `listmap<int>`, how many pointers in the data structure?
  - $n$
  - $n + 1$
  - $2n$
  - $2n + 1$
- If a server is already running, what system call is used by the client to gain access to a server's socket?
  - `accept(2)`
  - `bind(2)`
  - `connect(2)`
  - `listen(2)`
- Which of the following is an IPv4 internet address?
  - 127.0.1
  - 2607:f8b0:4010:801::1010
  - 74.125.239.50
  - 740.625.239.50
- Using the OpenGL coordinate system from the project, the point (0,0) is shown at the center. Where is the point (+1,+1)?
 

|     |       |
|-----|-------|
| (A) | (B)   |
|     | (0,0) |
| (D) | (C)   |
- If `operator[]` were implemented for `std::list`, what would be its speed?
  - $O(1)$
  - $O(\log_2 n)$
  - $O(n)$
  - $O(n \log_2 n)$
- If two or more threads access the same variable without any locks, what happens?
  - deadlock
  - race condition
  - runtime error
  - segmentation fault
- What is: `foo x()`?
  - `x` is a `foo` variable initialized by the empty initializer list.
  - `x` is a function with no arguments which returns a `foo`.
  - `x` is a variable of type `foo` initialized by the default ctor.
  - `x` is a variable of type `foo` initialized to 0 by default.
- Which is a correct `catch` statement?
  - `catch (domain_error error)`
  - `catch (domain_error& error)`
  - `catch (domain_error* error)`
  - `catch (domain_error~ error)`
- Which is based on an array of pointers to fixed sized blocks, where these blocks are never moved during expansion?
  - `deque`
  - `list`
  - `map`
  - `vector`
- Given `vector<int> v;`, which will produce the address of the first element of `v`?
  - `int* a = &*v.begin();`
  - `int* b = &v.begin();`
  - `int* c = *&v.begin();`
  - `int* d = *v.begin();`
- Given `class foo { ~foo(); };`, what is the proper way to define the destructor outside the class?
  - `foo::~!foo() {}`
  - `foo::~~foo() {}`
  - `foo~::~foo() {}`
  - `~foo::~foo() {}`
- A `foo` is an arbitrarily large object, and `f` does not intend to modify it. Which declaration is most correct?
  - `void f (const foo);`
  - `void f (foo&);`
  - `void f (foo);`
  - `void f (const foo&);`

Multiple choice. To the *left* of each question, write the letter that indicates your answer. Write **Z** if you don't want to risk a wrong answer. Wrong answers are worth negative points. **[12✓]**

|                                      |    |                        |       |
|--------------------------------------|----|------------------------|-------|
| number of correct answers            |    | $\times 1 =$           | $= a$ |
| number of wrong answers              |    | $\times \frac{1}{2} =$ | $= b$ |
| number of missing answers            |    | $\times 0 =$           | 0     |
| column total<br>$c = \max(a - b, 0)$ | 12 |                        | $= c$ |

- For `char** argv`, what expression would be equivalent to `argv.end()`, if `char**` were the name of a class ?  
(A) `&argv[0]`  
(B) `&argv[1]`  
(C) `&argv[argc-1]`  
(D) `&argv[argc]`
- After the following statement, what is the correct way to free the memory pointed at by `p` ?  
`foo *p = new foo[n];`  
(A) `delete* p;`  
(B) `delete[] p;`  
(C) `delete~ p;`  
(D) `delete p;`
- After the following system call, how many useful bits of information are in the variable `status` ?  
`pid_t child = waitpid (-1, &status, WNOHANG);`  
(A) 8  
(B) 16  
(C) 24  
(D) 32
- In order to prohibit a constructor from being used in an automatic conversion, what keyword is used ?  
(A) `delete`  
(B) `explicit`  
(C) `override`  
(D) `virtual`
- An attempt to define which of the following as a binary operator will always result in a compile-time error ?  
(A) `operator()`  
(B) `operator*`  
(C) `operator-->`  
(D) `operator[]`
- Which of the following works for a collection that supports only a forward iterator? If more than one is correct, choose the most efficient.  
(A) `for (auto i = c.begin(); i != c.end(); ++i) f(*i);`  
(B) `for (auto i = c.begin(); i != c.end(); i++) f(*i);`  
(C) `for (auto i = c.begin(); i < c.end(); ++i) f(*i);`  
(D) `for (auto i = c.begin(); i < c.end(); i++) f(*i);`
- Which of the following is a class defined in C++98 which is deprecated in C++11, for some arbitrary type `T` ?  
(A) `T*`  
(B) `auto_ptr<T>`  
(C) `shared_ptr<T>`  
(D) `unique_ptr<T>`
- What is the amortized time complexity of `map<int, int>::insert` ?  
(A)  $O(1)$   
(B)  $O(\log n)$   
(C)  $O(n)$   
(D)  $O(n \log n)$
- What is the amortized time complexity of `unordered_map<int, int>::insert` ?  
(A)  $O(1)$   
(B)  $O(\log n)$   
(C)  $O(n)$   
(D)  $O(n \log n)$
- An iterator is based on the half-open interval  $[a, b)$ . This is the set:  
(A)  $\{x \mid a < x < b\}$   
(B)  $\{x \mid a < x \leq b\}$   
(C)  $\{x \mid a \leq x < b\}$   
(D)  $\{x \mid a \leq x \leq b\}$
- Templates in C++ implement what kind of polymorphism ?  
(A) ad hoc conversion  
(B) ad hoc overloading  
(C) universal inclusion  
(D) universal parametric
- Given the following declarations, which statement will print a string ?  
`vector<string*> v;`  
`auto& i = v.begin();`  
(A) `cout << i;`  
(B) `cout << *i;`  
(C) `cout << **i;`  
(D) `cout << ***i;`