

Computer Science 140: Object-Oriented Programming with C++

Midterm

CRN: 33323 & 37933

October 18, 2018

This exam has 25 questions on 10 pages, front and back, including 1 extra credit set, for a total of 100 points plus an additional 5 extra credit points.

For all questions that do not specifically ask if the code is syntactically correct, assume it is.

Name: _____

1. (4 points) What are the three main characteristics of object-oriented programming languages:

Solution:

1. Data Hiding (or data encapsulation or encapsulation)
2. Polymorphism
3. Inheritance

2. (2 points) What is a variable?

Solution: A named memory location that can vary

3. (2 points) What is a pointer?

Solution: A variable that stores a memory address

4. (3 points) Which of the three characteristics of Object-Oriented Programming languages does the following code represent:

```
1  class A {  
2  private:  
3      int _x;  
4  };
```

Solution: Data hiding (or data encapsulation or encapsulation)

5. (3 points) Which of the three characteristics of Object-Oriented Programming languages does the following code represent:

```
1  class A {  
2  };  
3  
4  class B : public A {  
5  };
```

Solution: Inheritance

6. (3 points) Will the following code compile and run? Why or why not?

```
1  class A {  
2  };  
3  
4  int main(int argc, char *argv[]) {  
5      A a;  
6      A b(a);  
7      A c = a;  
8      return 0;  
9  }
```

Solution: Yes, because even though the default constructor, copy constructor and assignment operator are not explicitly declared, they exist implicitly if nothing no constructor etc are declared.

7. (4 points) What will the following code print, if run using the command below? Assume that the C++ code is compiled into a program named `program`.

```
1 $ program hello world
```

```
1 #include <iostream>
2 using std::cout;
3 using std::endl;
4
5 int main(int argc, char *argv[]) {
6     cout << argv[1] << " " << argc << " " << argv[1] << endl;
7     return 0;
8 }
```

Solution: hello 3 hello

8. Give the range of numbers representable by the following types (using powers of 2 is permitted, for bit sizes greater than 16):

(a) (2 points) `uint64_t`

Solution: 0 to $2^{64} - 1$

(b) (2 points) `int16_t`

Solution: -32768 to 32767

(c) (2 points) `uint8_t`

Solution: 0 to 255

- (d) (2 points) What if a new type were created that is named `int13_t`, what range numbers can be represented?

Solution: -4096 to 4095

9. For each of the following variable declaration/definition, indicate if the memory comes from the stack or the heap, or unknown.

(a) (2 points)

```
1 void foo() {  
2     uint8_t array[10];  
3 }
```

Solution: stack

(b) (2 points)

```
1 void foo() {  
2     uint8_t data;  
3 }
```

Solution: stack

(c) (2 points)

```
1     std::string *str;
```

Solution: unknown

(d) (2 points)

```
1 void foo() {  
2     uint8_t *array = new uint8_t[10];  
3 }
```

Solution: heap

10. (4 points) Are the following class declarations equivalent (i.e. do the two declarations result in the same data and method members with the same protections), why or why not?

```
1 class A {  
2     int _x;  
3 public:  
4     A();  
5     A(const A &other);  
6     ~A();  
7 };
```

```
1 struct A {  
2     private:  
3         int _x;  
4 };
```

Solution: Yes they are because `_x` is private in both the class and struct declaration, and because the default & copy constructor and destructor implicitly exist in the struct.

11. (2 points) The C++ Language very nearly contains the ____ programming language as proper subset.

Solution: C

12. (3 points) Assume variables `duck` and `boat` are declared to be `float` and are initialized. Write a sequence of lines of code that cause the values stored in `duck` and `boat` to be exchanged if the value of `duck` is not less than `boat`.

Solution:

```
1  if (duck >= boat) {  
2      double temp = boat;  
3      boat = duck;  
4      duck = temp;  
5  }
```

13. (3 points) Use the condition operator (`x?y:z`) to write a very compact expression that assigns the maximum of variables `n1` and `n2` to the variable `max`. You should assume that any variables you use have been declared and initialized appropriately.

Solution:

```
1  max = n1 > n2 ? n1 : n2;
```

14. (2 points) Whats the difference between the keywords `class` and `struct`?

Solution: For `class` the default protection is private, whereas for `struct` the default protection is public.

15. Write Boolean expressions that represent the given English expressions. Assume any variables used have been declared and initialized.

(a) (2 points) `alpha` is greater than 1

Solution:
1 `alpha > 1`

(b) (2 points) `x` is odd

Solution: One possible answer:
1 `x % 2 == 1`

(c) (2 points) `x` and `y` are odd

Solution: One possible answer:
1 `x % 2 == 1 && y % 2 == 1`

(d) (2 points) `ch` is an upper case alphabetic character (between 'A' and 'Z').

Solution: One possible answer:
1 `ch >= 'A' && ch <= 'Z'`

(e) (2 points) `digit`, which is of type `char`, has a value that is indeed a digit.

Solution: One possible answer:
1 `digit >= '0' && digit <= '9'`

16. (4 points) Circle each variable name below that is invalid

- (a) `variable_name`
- (b) `1temp` ✓
- (c) `class` ✓
- (d) `_variable`
- (e) `public_`
- (f) `CONST`
- (g) `review-count` ✓
- (h) `connect!` ✓

17. Convert the following mathematics expressions to C++ expressions. Use the declarations provided. Indicate the appropriate header file for any library function used. Be sure you initialize any variables whose values you are using to reasonable values for the library functions you are using.

```
1 int x, y; //declaration for a) and b)
```

- (a) (2 points) $y = x^4$

Solution: One possible answer:

```
1 y = x * x * x * x;
```

- (b) (2 points) $y \geq |x|$

Solution: One possible answer:

```
1 #include <cmath>
2 y >= abs(x);
```

```
1 double p, x, y, z, area; //declaration for c) through e).
```

- (c) (2 points) $z = x^{2.3}$

Solution: One possible answer:

```
1 #include <cmath>
2 z = pow(x, 2.3);
```

- (d) (2 points) $z = \text{square}^{\sqrt{\text{square}}}$

Solution: One possible answer:

```
1 #include <cmath>
2 z = pow(square, sqrt(square));
```

- (e) (2 points) $p = \frac{x^3+y}{x^3-y}$

Solution: One possible answer:

```
1 p = (x * x * x + y) / (x * x * x - y);
```

18. (3 points) What is the difference between the literals '`\0`' and '`"0"`'?

Solution: '`\0`' is a char with the value 0, whereas '`"0"`' is a string with the character 0.

19. (2 points) Each of the following lines of code purport to round the results of the division of doubles to the nearest integer value (but still of type double). All are syntactically correct C++ code, but some do not round correctly. Tell which rounds down, up, or to the nearest integer value, or is not reasonable

Assume that `math.h` or `cmath` has been included, and that all variables have appropriate values.

1 `double x, y, z;`

- (a) (1 point) `z = ceil(x/y);`

Solution: up

- (b) (1 point) `z = ceil(x/y-0.5);`

Solution: nearest integer value

- (c) (1 point) `z = floor(x/y-0.5);`

Solution: unreasonable

- (d) (1 point) `z = floor(x/y+0.5);`

Solution: nearest integer value

- (e) (1 point) `z = floor(x/y);`

Solution: down

20. (3 points) If you remove both of the ampersands (&) in the code below, what does the function given here do? Why?

```
1 void func(int& x, int& y) {  
2     int t = x;  
3     x = y;  
4     y = t;  
5 }
```

Solution: Nothing, since the arguments to the function are now pass-by-value.

21. (3 points) Write a void function definition for a function called zeroBoth that has two call-by-reference parameters, both of which are variables of type int, and that sets the values of both variables to 0.

Solution: One possible solution

```
1 void zeroBoth(int &x, int &y) {  
2     x = y = 0;  
3 }
```

22. (3 points) Define the concept of function overloading and how it relates to function overriding.

Solution: Overloading is giving the same name to a function and differentiating based on the number, type and order of the input parameters. Overriding is giving the same name to a function with the same parameters and differentiating based on where in the inheritance hierarchy the function is.

23. (3 points) Express the last line of the code below without using the arrow operator ('->'). Assume all the called methods have been properly declared and defined.

```
1 B *b = new B;  
2 b->foo();
```

Solution:

```
1 (*b).foo();
```

24. (3 points) What's the difference between an object and a class?

Solution: A class is an abstract data type whereas an object is an instance of a class.

EXTRA CREDIT: Answer the following extra credit question. You will be given credit for a maximum of 5 points.

25 (5 points (bonus))

Read and analyze the code below. Assume all needed headers are included, and that the code is syntactically correct. What will be printed to the console for the following code:

```
1  class A {
2  protected:
3      void recursive(int x) { if (x == 0) recursive(3.0); }
4      void recursive(double x) {
5          cout << "x = " << x << endl;
6          if (x < 0) recursive(x+1);
7      }
8  };
9
10 class B: public A {
11 public:
12     B(int x) { recursive(x); }
13
14 protected:
15     void recursive(int x) {
16         if (x > 0) recursive((double)(x-1));
17         cout << "x = " << x << endl;
18     }
19 };
20
21 int main(int argc, char *argv[]) {
22     B b(5);
23     return 0;
24 }
```

Solution:

```
1  x=0
2  x=1
3  x=2
4  x=3
5  x=4
6  x=5
```