Object Oriented Programming & Design - Monsoon 2024

Final Examination Questions (4-Credit)

SET-B

Name: **Roll number:**

Question Structure and Instructions

Please write your roll number **on each page of the question paper** above the top margin. This paper consists of two sections:

1. The 1st section consists of 15 short conceptual questions each carrying 3 points.
2. The 2nd section consists of 3 longer questions each carrying 5 points.
3. Please write the set number of question paper on the answer sheet and the attendance sheet.
4. **A short justification for each answer is necessary, but it should not exceed 2-3 lines of explanation.** Please note that adding unnecessary sentences to your answers can lead you to lose marks, even if a part of it contains the right answer.
5. You can attempt questions in any sequence, by giving the appropriate question number.

1 Short Conceptual Questions (3x15=45 points)

A1 Consider the following program:

```
int main(void) {
    int n;
    cin >> n;
    assert (n >= 0);
    for (unsigned int i = 0; i < n; i++) {
        cout << i;
    }
```

What will be the output if (i) the user inputs 5, and (ii) the user inputs -2? Justify briefly.

(i) 01234 (space may or may not be between the characters; 1.5 marks)

(ii) assert n >= 0 failed / assert failed (1.5 marks)

A2 Suppose you are representing a graph using a linked data structure. Is creating a smart pointer to link the next node a good idea? What type of smart pointer is suitable for this use case?

Yes, smart pointers are a good idea – 1.5 marks

It is better to use weak_ptr here, because there might be circular links in a graph – 1 + 0.5 marks

A3 Suppose you want to sort a *map* < *vector* < *int* >> using the sort given by STL's algorithm library. Is this a feasible idea? If not feasible, why is it not feasible? If feasible, how can you use it?

Yes, feasible (1.5 marks)

You need to define either an operator < function or comparator function (1.5 marks)

A4 A RAM drive is a block of random-access memory that a computer's software is treating as if the memory were a disk drive. Suppose you create a RAM drive for your own usage. Would a read or write go through the Virtual File System?

Yes, it would go through – 1.5 marks

Even writes to files outside secondary storage go through VFS – 1.5 marks

A5 Consider the following code:

```
int array[10] = {0};
auto my_itr = new Iterator<int>;
for (my_itr = array.begin(); my_itr != array.end(); my_itr++) {
    cout << *my_itr;
}
```

Is this code correct? What will be its output if so? If not so, how can you fix the code?

No, this code is not correct (1 mark), since an iterator cannot be used with an ordinary array (1 mark). You can fix the code by either using STL's array/vector or changing the iterator to a counter (either of them is fine, 1 mark)

A6 Suppose you define a function using the following code:

```
template<Type S, Type T>
auto fun(S s, T t) {
    return s * 2 + t;
}
int main(void) {
    cout << fun<int, int>(5.0, 4);
}
```

First check the syntax of the function fun. Is it correct? If not so, how can you make it correct? Then, write the correct output.

No, the syntax is not correct (1 mark)

auto fun(S s, T t) -> DeclType(s + t) (1 mark)

14 (1 mark) [note: 14.0 is wrong]

A7 Consider a bash shell program that requires you to count the number of words in a PDF file. The conversion of PDF to text on console is done using the following command:

```
pdftex <PDF–FILE> –
```

The counting of words is done by the command:

```
wc <FILE–NAME>
```

How can you connect the above two commands without using any file? Justify the logic.

`Using pipes (|) / pdftex <PDF-FILE> - | wc (2 marks)`

Pipes are used to connect the output of one command with the input of another command (1 mark)

A8 Suppose you create a smart pointer, but have not defined any global function to destroy the object. Is there any other way of specifying how to destroy the object?

Yes, possible (1 mark)

By specifying a lambda function as destructor (2 marks)

A9 Assume that you want to create a library that works only with a variety of numbers (unsigned int, int, unsigned long, long, float, double). Is templates the right way to use, for creating the functions and classes of this library? How would you ensure that non-numbers are rejected?

Yes, templates are a good choice (1 mark)

Either constraints or static checking (2 marks)

A10 Assume that a program takes 100 ms to complete on a single core. A developer identifies that 70% of the program can be executed in parallel, in 8 threads. If we assume that the program is being run on a 8-core machine, what will be its total execution time after the developer's use of parallelism?

70% of the program now takes (0.7 x 100)/8 = 8.75 ms (1 mark)

30% of the program now takes 0.3 x 100 = 30 ms (1 mark)

Total execution time = 38.75 ms (1 mark)

A11 Suppose you decide to implement a function that accepts two arguments of same type, but the actual type can be different. Is this possible using templates? If so, specify the function's declaration. If not so, specify the alternative technique.

Yes, possible (1 mark)

2 marks for Declaration: template<type T>

void fun(T t, T s);

A12 Consider the two distinct loops in the following code fragment:

```
vector<int> array{0, 3, 5};
for (int i = 0; i <= array.length(); i++) { //Loop 1
    array[i] = array[i] * 2;
}
for (int i = 0; i < array.length(); i++) { //Loop 2
    array.at(i) = array.at(i + 1) + 1;
}
```

Assume that either Loop 1 or Loop 2 is used in the code. What will be the outputs in either case?

Loop 1: Either segmentation fault or no output / 0 6 10 (1 mark)

Loop 2: Array out of bounds exception raised and program will not run any further (1 + 1 marks)

A13 Consider the following fragment of code:

```
class MyClass {
    int x;
    public:
    MyClass::increment() { x *= 10; }
    MyClass::MyClass() {
        x = 1;
    }
    MyClass::MyClass(MyClass &m) {
        x = m.x;
    }
};
int main(void) {
    MyClass m, n;
    m.increment();
    n = m;
    cout << m.x << " " << n.x;
    return 0;
}
```

Is the above code correct? If so, what will be the output? If not correct, explain what is the problem.

The above code is wrong (1 mark), because = operation is not defined (2 marks).

A14 Is there something wrong in the following code? If so, say what is wrong. If not so, give the output with justification.

```
int main() {
std::vector<int> vec = {1, 2, 3, 4, 5};

for (std::vector<int>::iterator it = vec.begin(); it != vec.end(); ++it) {
    *it *= 2;
}

for (std::vector<int>::iterator it = vec.begin(); it != vec.end(); ++it) {
    std::cout << *it << " ";
}

return 0;
}
```

No, this code is correct (1 mark)

Output: 2 4 6 8 10 (2 marks)

A15 Consider the case of a protected C++ member function that needs to be extended in a different class. However, the extended function should not be allowed to be extended any further. What is the easiest way of doing it?

2 solutions – use final keyword in class definition (3 marks)

Alternatively, inherit in private mode (3 marks)

2 Long Questions (5 x 3 = 15 points)

B1 Write a bash script that changes the permission to read, write and execute (for current user) all files with the first three letters of "abc", and removes the permission to read, write and execute (for current user) all files the first three letters of "def". Note that minor mistakes in syntax are acceptable.

```
for $( ls abc*); do
     chmod u+rwx $1
done
for $( ls def*); do
    chmod u-rwx $1
done
```

(a) 1 mark for using "ls"

(b) 1 mark for using "for" loop AND using "ls" inside it

(c) 1 mark for using $1

(d) 1 mark for using chmod command

(e) 1 mark for using u+rwx and u-rwx along with chmod

B2 Suppose the Ministry of Environment wants to create a technique of keeping track of air pollution in each major city of India's states and union territories. The air pollution consists of metrics like PM2.5, PM10, NO2 and SO2 at each hour of the 365 days a year. Design classes with data members and appropriate function declarations to keep track of the above data. You may use templates and STL if you prefer. You must follow the right object-oriented principles.

```
class StateOrUT { char *name; City *cities; };
class City { char *name; Pollutants p[366]; };
class Pollutants {
    private:
    float PM25, PM10, NO2, SO2;
 };
```

(a) 2 marks for the classes StateOrUT and City.

(b) 1 mark for either Pollutant class OR having PM2.5, etc as members of City class

(c) 1 mark for the above being an array or vector

(d) 1 mark for having cities pointer in StateOrUT class

B3 The Cricket World Cup consisted of a total of 10 national teams. The first round consisted of a round-robin format, where each team played everyone else. A win would fetch a total of 4 points, whereas a draw would fetch 2 points (for the sake of simplicity, assume that ties are arbitrarily resolved). The top four teams qualify for the semi-finals, and the winner of the semi-finals play the finals to select the Champion. Design a class structure that keeps track of each team playing the games, the qualifying teams and the champion. You may assume that a user is ready to give the input of each match's result.

```
class Match {
    Team team1, team2;
    int result;
};
class Team {
    char *name;
    int points;
};
class WorldCupSchedule {
    Match *firstRound;
    Match semiFinal1, semiFinal2, final;
};
```

(a) 3 marks (1 mark each) for the three classes with data members

(b) 1 mark for having data members for two teams per match

(c) 1 mark for using pointers / vector for firstRound and data members for semi-finals and final

(d) Note that use of aggregation is mandatory; -2 without aggregation being used

(e) Inheritance is NOT needed; -2 in case the matches (eg, final inherits from semi-final) use incorrect inheritance