Object Oriented Programming & Design - Monsoon 2024

Final Examination Questions (2-Credit)

Set-A

Name of the Student:

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 10 short conceptual questions each carrying 3 points.
2. The 2nd section consists of 4 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 (3x10=30 points)

A1 What will be the output of the following?

```
void fun1(int *a) {
    *a = *a + 1;
}
void fun2(int &a) {
    a = a + 1;
}
void fun3(int a) {
    a = a + 1;
}
int main(void) {
    int a = 5;
    fun1(&a);
    cout << a << endl;
    fun2(a);
    cout << a << endl;
    fun3(a);
    cout << a << endl;
```

6 (since a pointer is used, the changed value is reflected) – 1 mark

7 (since call-by-reference is used, the changed value is reflected) – 1 mark

7 (since call-by-value is read, the changed value is NOT reflected) – 1 mark

Full marks if any two of the above are justified, but the right output/number per line is needed.

A2 What will be the output of the following code?

```
class abc {
    int core, indicator;
    public:
    abc() { core = 10; indicator = 0; }
    abc(abc &a) { core = a.core; indicator = 1; }
    abc(int val) { core.val = 5; }
    int getCore() { return core; }
    boolean getIndicator() { return (boolean)indicator; }
};
void fun(abc x) {
    cout << x.getCore() << " " << x.getIndicator();
}
int main(void) {
    abc obj(0);
    fun(obj);
    return 0;
}
```

Solution 1: Syntax error in default constructor with argument (1.5 marks). So the program will not compile, and there is no possibility of running the program (1.5 marks for either of them).

Solution 2: Assuming core = val. Output will be: 5 1 (2 marks) Call-by-value calls the copy constructor, and since 5 is the value of core, and indicator is set to 1. (1 mark if copy constructor is mentioned)

A3 Consider a situation where you want to model the deployment of a smart home. The home consists of numerous floors, and each floor consists of a series of rooms, doors, windows and electrical appliances. A planner wants to deploy smart home devices to control each of them. Is modeling the home as a base class, and the floors and rooms, etc as derived class a good design? Explain why or why not.

No, this is not the right solution (1.5 marks), because using derived class/inheritance is better when one is a sub-type of the other (1.5 marks)

A4 What will be the output of the following program?

```
Program p1.cpp
int x = 0;
void abc(int x) {
    cout << x;
}
Program p2.cpp
int main(void) {
    abc(5);
    return 0;
}
```

5 (1 mark) Although there is a global variable x, the local variable is always used whenever it is available (2 marks).

A5 Suppose you are writing a Makefile for a program that you know can be executed on a machine where the same OS is likely to be used, but the libraries used need not be present. What can you do to ensure that it is still possible to use the program?

Need to use static building / static library – 3 marks

A6 A key challenge faced by modern programmers is that code generated by machines need to be checked for correctness. Suppose you generate a program, and then test it using two distinct inputs. Is it guaranteed that this program is correct? Justify.

No, it does not guarantee correctness – 1 mark Because there could be other possible inputs for which the program is incorrect – 2 marks

A7 Does the following program have any problem, and if so, what is it?

```
void allocate_and_initialize_memory_block(int *a) {
    a = new int[10];
    for (int i = 0; i < 10; i++) {
        a[i] = 0;
    }
}
int main(void) {
    int *mem = NULL;
    allocate_and_initialize_memory_block(mem);
    mem[1] = 10;
    cout << *mem;
    delete mem;
}
```

Segmentation fault – 1 mark Because the function is called using call-by-value, the value of mem does not change – 2 marks

A8 Which of the loops is likely to run faster in the following code, and why?

```
int main(void) {
    int x[1000][1000];
    initialize(x);
    for (int i = 0; i < 1000; i++) { // Loop 1
        for (int j = 0; j < 1000; j++) {
            x[i][j] = 10;
        }
    }
    for (int i = 0; i < 1000; i++) { // Loop 2
        for (int j = 0; j < 1000; j++) {
            x[j][i] = 10;
        }
    }
```

The first solution will run faster because it uses adjacent/consecutive locations in memory (1.5 marks), so there will be fewer cache misses / higher cache hits (1.5 marks).

A9 Is the following strategy of taking input from user a good idea? If so, justify when it should be used. If not so, explain the alternative technique that should be used.

```
int main(void) {
    char x[50];
    gets(x);
    ...
}
```

No, it is not a good idea – 1 mark

Because it can lead to a user giving an input longer than the length of x, possibly writing on other memory regions – 2 marks

A10 Suppose you create a git repository, and want to release a program. A second user gets added to your team, and you decide to assign him/her to add a few experimental features. Your strategy is to add them to your program only when the experimental features are thoroughly tested. How would you be able to eventually add the second user's code to your software in the git repository?

Need to create a branch first for 2nd user (1 mark), and then when it is ready, need to merge the changes (1 mark) Branch to keep the experiments separate – 1 mark

2 Long Questions (5 x 4 = 20 points)

B1 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 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

B2 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

(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

B3 Consider the following program that manipulates a string:

```
int main(void) {
    L1: string str("");
    L2: string str2(str);
    L3: str2 = str + "abc";
    L4: cout << str2 << str;
    return 0;
}
```

Now, answer the following questions:

(a) Which functions are used to initialize the variables str and str2?

(b) Which technique is used to operate on L3?

(c) What will be the output of the program?

(a) str is initialized using constructor with argument, str2 using copy constructor (1 mark + 1 mark)

(b) Operator overloading (1 mark)

(c) abc (str2 has abc and str has empty string) (1 mark + 1 mark)

B4 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? Now suppose both the original class and the extended class have their own constructors. How would you define them? Write a fragment of code to design both the cases.

1 mark – By inheriting in private mode

1.5 marks – Example of inheriting in private mode as shown below

2.5 marks – Defining the constructors in both base class and derived class

```
class BaseClass {
    protected:
    void fun();
    public:
    BaseClass() { }
};
class DerivedClass: private BaseClass {
    public:
    DerivedClass() { }
};
```