THE CITY UNIVERSITY

LONDON

No: 000

MSc Degree in Object-Oriented Software System

Object-Oriented Programming in C++ (P206)

May 2003

Answer TWO questions ONLY.

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1. a) Define a class `Point` containing x- and y-coordinates on a screen. Include a constructor and appropriate selector methods. (15%)

   b) Write an appropriate overloading of the `==` operator for your class. (20%)

   c) A polygon may be represented as a sequence of points (using the C++ `vector` type). Assuming a class `Graphics` with a method

```
// draw a line from (x1,y1) to (x2,y2)
void draw_line(int x1, int y1, int x2, int y2);
```

   complete the following class by adding one or more fields and filling in the bodies of the methods:

```
class Polygon {
    // field(s)

public:
    // add a point to the polygon
    void add_point(const Point &p) { ... }

    // draw the outline of the polygon by
    // connecting the points
    void draw_outline(Graphics &g) { ... }
};
```

   (25%)

   d) Explain in detail what happens in the following:

```
{
    Polygon p1;
    // add some points to p1;
    Polygon p2 = p1;
    Polygon p3;
    p3 = p1;
}
```

   (25%)

   e) Suppose a procedure were to take a `Polygon` argument. What means of passing the parameter are offered by C++, and in what situations should they be used? (15%)

2. a) Describe the C++ counterparts of the following Java concepts. How are they different from the Java versions?

   i) abstract classes (10%)

   ii) dynamic storage (10%)

   b) Write a function that counts the negative numbers in a `list` of integers. (15%)

   c) Write a generic procedure that takes two `list`s and modifies the first list by appending the contents of the second. (The second list is unchanged.) (25%)

   d) Explain the importance of the following parts of the `vector` class:

```
vector(const vector<T> &v);

vector<T> & operator= (const vector<T> &v);

virtual ~vector();
```

   (15%)

   e) Suppose a program is intended to read a file, but must ensure that it has exclusive access to the file while it is open, using the following functions to obtain a lock on a file and release it:

```
int lock_file(string filename);
void release(int lock);
```

   The first function returns a lock descriptor, which is used by the second to release the lock.

   The file should be locked before it is opened, and unlocked after it is closed. The file should be closed and the lock released as soon as it is no longer needed, and this should happen even if an exception occurs in the file reading code. Sketch a solution using the “resource acquisition as initialization” technique, and explain why it works. (25%)

3. Consider the following class for a simple payroll program:

```
// Base class for employees in a payroll.
// In derived classes, employees will be paid by hours
// worked or amount of goods sold.
class Employee {
protected:
        // employee's name
        const string name;

        // pay earned so far this month (in pounds)
        double pay;

public:
        Employee(const string &n) : name(n), pay(0) {}

        // employee's name
        string get_name() const { return name; }

        // pay earned so far this month (in pounds)
        double get_pay() const { return pay; }

        // rest pay level (after monthly pay round)
        void reset_pay() { pay = 0; }

        // add pay for working h hours
        virtual void work_hours(double h) {}

        // add pay for selling amount (in pounds)
        virtual void sell(double amount) {}
};
```

a) The class uses the keyword `const` in three places: before a field, before a parameter and after method declarations. Explain the meaning of each kind of `const`. (15%)

b) What are the visibilities of the fields and methods in this class, and why is this reasonable? (10%)

c) What is the significance of the presence or absence of the `virtual` keyword on methods of this class? (10%)

Question 3 continues over the page…

d) Define two derived classes of `Employee`:

HourlyEmployee for employees who are paid at a given rate (varying between employees) per hour, and

CommissionEmployee for employees who are paid a commission: a percentage of the amount they sell. Again this percentage is different for each such employee.

(35%)

e) Use the classes from the previous part to define a class for employees who are paid both hourly and by commission. Include any changes you might have to make to your answer to the previous part. (30%)