UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

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MSc Degree in Computing Science
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the Diploma of Membership of Imperial College

PAPER M351

OBJECT ORIENTED DESIGN AND PROGRAMMING

Monday, May 13th 1996, 10.00 - 12.00

Answer THREE questions

For admin. only: paper contains
5 questions
2 pages (excluding cover page)

1a Explain the features of C++ that make it possible to define data types in the same way as built-in types.

b Provide a suitable class declaration (but not definition) for a String class which will allow one to create, assign, concatenate, compare and input and output strings lexicographically.

c Add to the above declaration a means of multiplying a string by an integer. e.g. "abc" multiplied by 3 would give "abcabcabc". Write a correct definition for this function using the operations defined in the String class.

2a An automatic charging system is being designed for vehicles travelling within a city centre using identification by roadside sensors. The rules by which charges are made are as follows:

i cars are only charged between the hours of 0700 and 2200.

ii a vehicle is only charged once each day

iii lorries are charged at 4 times the standard rate

iv buses are not charged

v to encourage commuters to share journeys, if a non-resident's car incurs charges on more than three days in the same week, the extra days are charged double.

vi Cars of residents are charged at one-half of other cars.

Draw an object diagram showing a set of possible classes to describe this situation showing attributes and operations to implement a charging formula and accumulate charges in units (which need not be priced).

b Write the C++ code to implement the classes and charging formula for the example in part a for each category of vehicle. You may assume the existence of functions hour() and day() which return the time of day in hours and the number of days from some baseline starting at the beginning of the week respectively.

Parts a and b carry respectively 40% and 60% of the marks

3a What are the three modelling techniques used by OMT and what aspects of a design does each of them capture?

b The quantities in stock of all items in a supermarket are stored on a central computer. When a customer makes a purchase the cash till computes the total and provides change to the customer. At the same time the central computer adjusts its stock records and prints out when the quantity of any item falls below the reorder level.

Represent the elements of this situation using the three models. Keep these models at a suitably abstract level and avoid making them too detailed.

Parts a and b carry respectively 30% and 70% of the marks

Turn over ...

4a Explain the differences between implementing a container class (such as a list) by means of inheritance and by the use of templates in C++. What advantages and disadvantages are there in the approach taken by C++?

b Consider the following template classes which define a set of (not balanced) binary trees. Each of the nodes of the tree are items of class Node and the root of the tree is of class Tree.

```
template <class T>
class Node {
   Node <T>* left, right;
   T _value;
public:
   Node (T& elem);
   T value() ;
   Node <T>* insert(T& elem);
   Node <T>* lookup(T& elem);
};

template <class T>
class Tree {
   Node<T>* _value;
public:
   Tree() : _value(0) {}
   Node <T>* insert(T& elem);
   Node <T>* lookup(T& elem);
};
```

Write definitions of the member functions. *insert* should not create a duplicate node and *lookup* should return a null pointer if the element is not in the tree.

Parts a and b carry respectively 30% and 70% of the marks

5a Outline the main features of the two classical approaches to the software engineering lifecycle: the 'waterfall' and 'spiral' models. What are the problems in the first which have led people to favour the second?

b What features of object-oriented techniques promote reuse of software components compared with other approaches? Suggest typical areas in which the different techniques are particularly useful.

c You are asked to develop an aircraft simulator package on a standard workstation platform. Discuss the relevance of your answers to parts a and b in approaching this task and how this would influence the way you organize the project.

End of paper