UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2001

BEng Honours Degree in Computing Part III
MSc in Computing Science
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the
Associateship of the City and Guilds of London Institute
This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science*

PAPER C327

THE PRACTICE OF LOGIC PROGRAMMING

Monday 30 April 2001, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

1   In the Fibonacci Sequence of integers: 1, 1, 2, 3, 5, 8, 13, 21, 34, ... , the first and second terms are both 1, and thereafter each term is the sum of the previous two.

a   Give a simple Prolog program for `fib(N, F)`, where F is the Nth term in the Fibonacci Sequence. The program should be able to find any desired term in the sequence. It should **NOT** be tail-recursive or use accumulators.

b   What happens when you run the Prolog query:

```
?- fib(N, 3).
```

c   Give a new Prolog program for `fib(N, F)` that is tail-recursive.

d   Implement `fib(N, F)` in CLP(R). This program need **NOT** be tail-recursive.

e   Trace the execution of the CLP(R) query:

```
?- fib(N, 3).
```

The five parts carry, respectively, 10%, 10%, 30%, 20%, 30% of the marks.

2   A fragment of English dealing with lecturers, students and courses includes the following sentences:

"Smith teaches Programming".
"John attends a course".
"Every lecturer teaches Hardware".
"Every student who attends Programming attends Graphics".
"Which lecturer teaches Graphics?"
"Does John attend Hardware?"

a   Express this fragment in Prolog grammar rule notation.

b   Extend the grammar rules in part a, so that they construct Prolog terms representing the semantics of valid sentences.

c   Sketch how you could build a simple natural language front end to a lecturer, student and course database, building upon the Prolog grammar rules in part b.

The three parts carry, respectively, 20%, 50%, 30% of the marks.

3a   Describe and explain the role of each of the main components of a typical CLP(FD) program.

b   Consider the following puzzle, which you are **NOT** required to solve:

> *The famous explorer, Sir Ranulf Smyth, returned recently from the Amazon rainforest, bringing with him four specimens of edible herbs that the local natives call Anganga, Butubuto, Chingi and Duroo.*
>
> *He gave his sister, Della Smyth, a famous TV chef and always on the lookout for exciting new ingredients, small amounts of the herbs for trying new recipes. She put the herbs in separate boxes made of Plastic, Quartz, Rubber and Steel and put labels on the boxes, coloured Fawn, Green, Hyacinth and Indigo.*
>
> *Of course, as is the way with such stories, you cannot assume that the list of herbs, the list of box materials and the list of coloured labels are in corresponding order.*
>
> *Della found that:*
>
> 1. *More people liked the herb in the Plastic box than they did Chingi.*
>
> 2. *The herbs in the boxes with Hyacinth and Indigo labels could not be used in the same recipes as Butubuto; and none of those three herbs could be used successfully with the herb kept in the Rubber box.*
>
> 3. *Duroo and the herb from the Steel box were both less popular than the herb with the Indigo label, and could never be used together with the herb from the Fawn-labelled Quartz box.*
>
> *What is the Hyacinth-labelled box made of and which herb does it contain?*

Show how you would express the puzzle in CLP(FD), in such a way that it computes the solution and outputs it in the following form:

I ?- solve_puzzle.

The hyacinth-labelled box is made of steel and contains the herb chingi.

Yes

The two parts carry, respectively, 25%, 75% of the marks.

4a   Give the top-level demo code for a Prolog expert system shell that provides "how" and "why" explanations and interacts with the user. Its style of interaction queries the user for all answers to a question not addressed by the knowledge base, before continuing with the investigation.

b   Give the lower level code for the procedures handling the query-the-user interaction.

c   Sketch out how the interaction procedure could be made to seem less wooden and stiff by including in the knowledge base pieces of natural language text (such as, for example, "Please give the normal symptoms suffered by the patient." or "Does the patient's family have a history of epilepsy?") for typical questions to the user.

The three parts carry, respectively, 40%, 40%, 20% of the marks.