

## 2008 Paper 6 Question 7

### Concepts in Programming Languages

- (a) Explain what is understood by *static* and *dynamic* scope in the context of programming languages.

Write a program fragment in pseudocode such that its execution under static scoping and under dynamic scoping yields different outcomes. Justify your answer.

[7 marks]

- (b) The type system of the programming language Pascal has a rich set of data-structuring concepts, including *variant records*.

Recall that variant records have a part common to all records of the type and a variable part (discriminated via an optional tag field) specific to some subset of records. For instance, consider the variant-record type `UBtree` of unary/binary branching trees below:

```
type kind = (unary,binary) ;

type UBtree = record
    value: integer ;
    case k: kind of
        unary: ^UBtree ;
        binary: record
            left: ^UBtree ;
            right: ^UBtree
        end
    end ;
```

Explain how variant records introduced weaknesses into the Pascal type system.

Give an encoding of the `UBtree` type as a datatype in SML, and explain why the aforementioned weaknesses do not arise in SML.

[7 marks]

- (c) Explain how *function types* are encoded in the programming language Scala, exemplifying your answer.

[6 marks]