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:

```pascal
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]