

## 2011 Paper 3 Question 6

### Concepts in Programming Languages

- (a) Give **one** difference and **one** similarity between the programming languages:
- (i) Algol and SIMULA [2 marks]
  - (ii) LISP and Smalltalk [2 marks]
- (b) What is the type of the expression `fn f => fn x => f(f(x))` inferred by the SML interpreter? Explain your answer. [6 marks]
- (c) Give an example in the SML Modules language of two distinct signatures, say `IN` and `OUT`, and of a functor that takes structures matching `IN` to produce structures matching `OUT`. [6 marks]
- (d) Comment on the mechanism for parameter-passing in the programming language Scala. [4 marks]

You may wish to consider the following two code samples.

```
def whileLoop( cond: => Boolean )( comm: => Unit )
  { if( cond ) comm; whileLoop( cond )( comm ) }

def qsort[T]( xs: Array[T] )( implicit o: Ord[T] ): Array[T]
  = if( xs.length <= 1 ) xs else
    { val pivot = xs( xs.length/2 )
      Array.concat
        ( qsort( xs filter (x => x.lt(x,pivot)) ) ,
          xs filter (x => x == pivot ) ,
          qsort( xs filter (x => x.lt(pivot,x)) ) ) } }
```