Foundations of Computer Science

(a) The polymorphic curried function \texttt{delFirst} takes two arguments, a predicate (Boolean-valued function) \( p \) and a list \( xs \). It returns a list identical to \( xs \) except that the first element satisfying \( p \) is omitted; if no such element exists, then it raises an exception. Code this function in ML. [4 marks]

(b) Use the function \texttt{delFirst} to express the polymorphic function \texttt{delFirstElt}, where \texttt{delFirstElt x xs} returns a list identical to \( xs \) except that it omits the first occurrence of \( x \). [2 marks]

(c) Carefully explain the polymorphic types of these two functions, paying particular attention to currying and equality. [4 marks]

(d) A list \( ys \) is a permutation of another list \( xs \) if \( ys \) is obtained by rearranging the elements of \( xs \). For example, \([2,1,2,1]\) is a permutation of \([2,2,1,1]\). Code an ML function to determine whether one list is a permutation of another. [4 marks]

(e) A list \( ys \) is a generalised permutation of \( xs \) if \( ys \) is obtained by rearranging the elements of \( xs \), where one element of \( xs \) is specially treated: it may appear any number of times (including zero) in \( ys \). For example, \([1,2,1]\) is a generalised permutation of \([1,2]\) but \([1,2,2,1]\) is not because two elements (1 and 2) appear the wrong number of times in it. Code an ML function to determine whether one list is a generalised permutation of another. [6 marks]

All ML code must be explained clearly.