2 Foundations of Computer Science (LCP)

(a) Write brief notes on the queue data structure and how it can be implemented efficiently in ML. In a precise sense, what is the cost of the main queue operations? (It is not required to present ML code.) [6 marks]

(b) Run-length encoding is a way of compressing a list in which certain elements are repeated many times in a row. For example, a list of the form \( [a, a, a, b, a, a] \) is encoded as \( [(3, a), (1, b), (2, a)] \). Write a polymorphic function \texttt{rl_encode} to perform this encoding. What is the type of \texttt{rl_encode}? [6 marks]

(c) The simple task of testing whether two lists are equal can be generalised to allow a certain number of errors. We consider three forms of error:

- element mismatch, as in \([1,2,3]\) versus \([1,9,3]\) or \([1,2,3]\) versus \([0,2,3]\)
- left deletion, as in \([1,3]\) versus \([1,2,3]\) or \([1,2]\) versus \([1,2,3]\)
- right deletion, as in \([1,2,3]\) versus \([1,3]\) or \([1,2,3]\) versus \([1,2]\)

Write a function \texttt{genEquals n xs ys} that returns \texttt{true} if the two lists \texttt{xs} and \texttt{ys} are equal with no more than \texttt{n} errors, and otherwise \texttt{false}. You may assume that \texttt{n} is a non-negative integer. [8 marks]

All ML code must be explained clearly and should be free of needless complexity.