2 Foundations of Computer Science (LCP)

(a) A *prime number sieve* is an algorithm for finding all prime numbers up to a given limit \( n \). The algorithm maintains a list, which initially holds the integers from 2 to \( n \). The following step is then repeated: remove the head of this list, which will be a prime number, and remove all its multiples from the list. Write code for the algorithm above as an ML function of type \( \text{int} \rightarrow \text{int list} \). \[4 \text{ marks}\]

(b) Consider the problem of eliminating all duplicates from a list of strings. Write code for a function of type \( \text{string list} \rightarrow \text{string list} \) such that the output contains the same elements as the input, possibly reordered, but where every element occurs exactly once. The worst-case performance must be better than quadratic in the length of the list. \[6 \text{ marks}\]

(c) Consider the task of determining whether a given *word* (a string) can be expressed by joining together various *chunks* (non-empty strings). If the chunks are *abra*, *cad* and *hal*, then the word *abracadabra* can be expressed as *abra*|*cad*|*abra*. Note that if the available chunks are *ab*, *bra*, *cad* and *abra*, then the first two are no good for expressing *abracadabra*, and yet a solution can be found using *cad* and *abra*. The chunks can be used any number of times and in any order.

Write code for a function that takes a list of chunks along with a word, and returns a list of chunks that yield the word when concatenated. For the examples above, the result should be ["abra", "cad", "abra"]. Exception Fail should be raised if no solution exists. \[10 \text{ marks}\]

*Note:* You are given a function \text{delPrefix} for removing an initial part of a string. For example, \text{delPrefix} ("abra", "abracadabra") returns "cadabra", but \text{delPrefix} ("bra", "abracadabra") raises exception Fail.

All ML code must be explained clearly and should be free of needless complexity. Well-known utility functions may be assumed to be available.