Problem-set 1: Haskell

Problem 1

Implement a module `ListOperations` that provides the function `lastElement`, which returns the last element of a list:

```
ListOperations> lastElement [1,2,3]
3
ListOperations> lastElement (take 10 [5..])
14
```

Specify the domain and the codomain of `lastElement`. Does `lastElement` always terminate?

Problem 2

Julius Caesar

Julius Caesar (100 B.C. - 44 B.C.) has already used an encryption technique to secure his messages. His methods was very simple:

```
rewrite 'A' as 'E'
rewrite 'B' as 'F'
...
rewrite 'Z' as 'D'
```

Implement a module `CharacterCoder` and:

1. Define the functions `charEncrypt` and `charDecrypt`, which take a single character as argument and return an encoded and decoded character, respectively:

```
CharacterCoder> charEncrypt 'a'
'e'
CharacterCoder> charDecrypt 'c'
'y'
```

2. Using the function `charEncrypt` and `charDecrypt`, implement the functions `encrypt` and `decrypt` that encode and decode a character string, respectively.

Note: The functions `charEncrypt` and `charDecrypt` should use a common auxiliary function. Try to find it.
Problem 3

A propos the Romans

Define the function \texttt{romanToInt :: String -> Int}, which takes a string denoting a roman number and returns the corresponding integer value:

Main\textgreater romanToInt "IV"
4
Main\textgreater romanToInt "CCCXXXIV"
334

The values of the roman digits are defined as follows:

\begin{align*}
I & = 1 \\
V & = 5 \\
X & = 10 \\
L & = 50 \\
C & = 100 \\
D & = 500 \\
M & = 1000 \\
\end{align*}

The roman system is an \textit{addition-system}, i.e. every digit has a specific value and the meaning of a roman number is the sum of all its character values. The roman system distinguishes between base characters ("I", "X", "C", "M") and auxiliary characters ("V", "L", "D").

In the roman system, the character for the greater value is always written on the left-hand side of the character denoting a smaller value. There is, however, one exception. In favor of denoting a concrete integer value with the least possible number of characters, we write "IX" rather than "XIIII". Therefore, if a character denoting a smaller value is written on the left-hand side of a character for a bigger value, we have to subtract its corresponding value from the final result (e.g. "IX" reads \(-1 + 10 = 9\)). However, it is not allowed to write more than one base character or any auxiliary character on the left-hand side of a bigger character (e.g. write "MCMLIX" for 1959, but "LM" is not allowed, instead write "CML" = 950).

Submission deadline: Thursday, September 20, 2001, 11am

Submission procedure: Submissions should be made electronically. Send your solution to pramod@cs.iastate.edu with a CC to lumpe@cs.iastate.edu.

On the department’s computer systems (HP’s), use the command \texttt{hugs} to start the Haskell interpreter.