

09.71.23/24 Tölvunarfræði IIa/II

Makeup exam

August 21st, 2000
14⁰⁰ – 17⁰⁰

The first 5 problems are for all students (both from Tölvunarfræði II and IIa) Problem 6 is only for students from Tölvunarfræði II, but problem 7 is only for students in Tölvunarfræði IIa (engineering students). In both cases **five best problems out of six count**.

All written materials and a calculator allowed.

1. a) Write in C++ the function

```
replace( string text, string s1, string s2 )
```

Any place where the string `s1` appears in `text`, then it is replaced with the string `s2`. The string `text` is not changed, but the new string is the return value of the function. For instance if the following statement is executed:

```
newName = replace( "Jóhann Hannesson", "nn", "nes" );
```

then the variable `newName` has the value "Jóhannes Hannesesson". Please note that the string `s2` is only substituted in for the substrings that appear in the **original** string `text`.

b) Explain why the last sentence in part a) is important. Show examples of problems that can come up if this condition is not used.

2. In a *multilist* each node has two or more data field and as many pointer fields. For example we can set up a simple phone directory in this way, where the data fields are two: name and phoneno. One of the pointers links the nodes alphabetically by names, but the other in order by phone numbers. The figure below show this more clearly:



a) Describe the main advantages and disadvantages of this data structure.

b) Write a function in C++ that takes as input a name, and deletes the node that contains that name out of a list like the one described above. Please note that the list has to be in a valid state after the deletion (i.e. no dangling pointers).

3. a) If node n is an **ancestor** of node m in a binary tree, is it certain that n is ahead of m in *i)* preorder, *ii)* inorder, *iii)* postorder listing of the tree? Give a convincing argument or a counterexample.

b) If node n is **to the left of** node m in a binary tree, is it certain that n is ahead of m in *i)* preorder, *ii)* inorder, *iii)* postorder listing of the tree? Give a convincing argument or a counterexample.

4. a) What is the lowest number (i.e. best case) and highest number (i.e. worst case) of probes in filling a hash table with M cells by using insertions. Under what circumstances do these cases appear?

b) Why is the function " $h(x) = x^2 \bmod M$ " not a good hash function for a hashtable with M cells? Assume that x is an integer.

5. If we apply the function `deleteMin` on a binary heap, and then put the deleted item immediately back in with the function `insert`, do we always end up with exactly the same tree as we started with? Give a convincing argument or a counterexample.

Only for students in Tölvunarfræði II:

6. Describe exactly (in words) a linear method to evaluate **prefix** expressions, corresponding to the one shown in the book for evaluating **postfix** expressions. Please note that the expression is read from left to right and you can only use one pass over the string.

Only for students in Tölvunarfræði IIa (engineering students):

7. We want to delete two values from a binary search tree. Do we get the exact same tree no matter which value is deleted first? In other words, does the order of deleted values matter for the shape of the resulting tree? Give a convincing argument or a counterexample.