1. Give an algorithm (in pseudocode) that performs an inorder tree walk without using recursion.

   *Hint:* there is a straightforward solution that uses a stack to replace recursion, and a more refined solution that needs only constant space.

2. The task is to produce a rough visualisation for a binary tree. The keys in the nodes are printed level by level, each level on its own line of text, left to right. If the node $x$ has both a left and a right child, it is printed as $x$; if only a left child, then $x$; if only a right child, then $x$; and if no children, then $x$. The nodes do not need to be vertically aligned. Thus, the binary tree

```
  9
 /\  
12 4
|   |
6   24
| |
3 11
```

would be visualised as

```
  _9_
12_ _4_
6   _24_
3 11
```

Give (in pseudocode) an algorithm that produces such a visualisation. You may use any data structures from the course as a part of your solution.

*Please see next page!*
3. Integer values have been stored to the leaves of a binary tree. Give an algorithm that stores into each internal node the sum of the numbers in the leaves in the subtree starting from the node.

4. (a) How many nodes are there in a complete binary tree of height 10? How about height 20, 30 or 40?

(b) Analogous to a binary tree, let a *decimal tree* be such that each node can have at most ten children, which are called \textit{child}_0, \textit{child}_1, \ldots, \textit{child}_9. How many nodes can a decimal tree have on level \(k\)? How many nodes in total can there be in a decimal tree of height \(h\)? What is the minimum height for a decimal tree with \(5,000,000\) nodes. How about \(5,000,000,000\) nodes, or \(5,000,000,000,000\) nodes?

(c) Suppose we have a complete binary tree that contains \(n\) nodes and has height \(h\). What is the minimum height of a decimal tree that contains the same amount of nodes? (Give your answer in terms of \(h\).) How many nodes would there be in a complete decimal tree of height \(h\)? (Give your answer in terms of \(n\).)

5. (a) Show the binary search tree that results when the keys 3, 11, 17, 5, 13, 2 and 7 are inserted, in that order, into an initially empty tree.

(b) Show the result of deleting first the key 5, then the key 11, from the binary search tree from part (a).

(c) If the keys 2, 3, 5, 7, 11, 13 and 17 are inserted into an initially empty binary search tree in a suitable order, the resulting tree will be complete. Give an example of such an order.