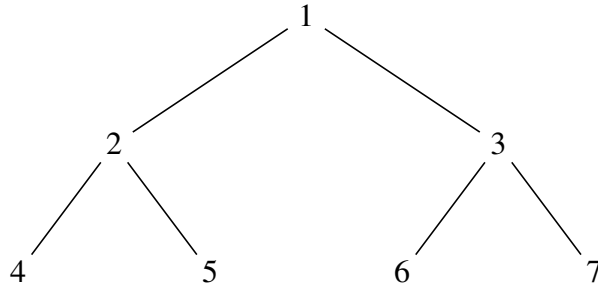


2004 Paper 13 Question 10

Introduction to Functional Programming

- (a) Define a polymorphic datatype `'a tree` to represent binary trees. [1 mark]
- (b) A *breadth-first* traversal of a tree walks over all the nodes at each level before proceeding to the next level. For example the breadth-first traversal of the tree:



visits the nodes in the order 1, 2, 3, 4, 5, 6, 7.

Define a function `breadth: 'a tree -> 'a list` such that `breadth(t)` returns the nodes of tree `t` in breadth-first order. [10 marks]

- (c) Define a polymorphic datatype `'a seq` to represent lazy lists. [1 mark]
- (d) Define a polymorphic datatype `'a ltree` to represent lazy binary trees. [3 marks]
- (e) Define a function `inorder` of type `'a ltree -> 'a seq` that traverses a lazy tree in-order, returning the nodes in a lazy list. (You should define any auxiliary functions you may use.) [5 marks]