Foundations of Computer Science

(a) Consider the following piece of ML code:

datatype 'a tree = Lf | Br of 'a * 'a tree * 'a tree;
exception Blair;

fun tony p Lf = true
  | tony p (Br(x,t1,t2)) = if not (p x) then raise Blair
  else tony p t1 handle Blair => tony p t2;

fun gordon p t = tony p t handle Blair => false;

(i) Code a function that returns the same results as gordon but makes no use of exceptions. [4 marks]

(ii) What property of binary trees does gordon express? [3 marks]

(b) Write brief notes on the ML type exn. [3 marks]

(c) Consider the following piece of ML code:

datatype 'a result = Ian of 'a | Cherie of exn;

fun what f x = Ian (f x) handle e => Cherie e;

We ask ML to evaluate the expression

map (what (tony (fn x => x <> 0))) [ta,tb]

and the response is as follows:

val it = [Ian true, Cherie Blair] : bool result list

What is the type of what (tony (fn x => x <> 0)), and what can we infer about the binary trees ta and tb? Justify both answers carefully. [5+5 marks]