

3 Concepts in Programming Languages (avsm2)

- (a) (i) Explain what a *monad* is in the context of a structure in a program. Define the two fundamental operations of a monad along with their types. You may use syntax from any programming language in your answer, but Haskell or OCaml are easiest. [2 marks]
- (ii) Describe a particular monad and a program fragment that uses it when coding in Haskell. [4 marks]
- (iii) Discuss briefly why monadic style programming may not be as necessary when coding in JavaScript or OCaml or Scala as it is in Haskell. [2 marks]
- (b) For each of the following OCaml declarations, if they pass the type checker give their inferred types, or if not then give a program fragment using them that would violate type safety:
- (i) `exception Exn of 'a` [2 marks]
- (ii) `let rec even = function 0 -> true | v -> odd (v-1)
and odd = function 0 -> false | v -> even (v-1)` [2 marks]
- (iii) `fun a b -> a (a b)` [2 marks]
- (iv) `fun a b -> b (a b)` [3 marks]
- (v) `fun a b -> a b b` [3 marks]