6 Concepts in Programming Languages (AM)

(a) Give an overview of the execution models (abstract machines) associated with Fortran, Lisp, Algol-60, Pascal, C, ML and Java. (These are not necessarily distinct.) Mention how storage allocation and deallocation is performed. [4 marks]

(b) Explain to what extent the above languages:

(i) provide static scoping [2 marks]

(ii) provide static type checking [2 marks]

(iii) are type-safe—for each language either state it to be type-safe or sketch a type-unsafe program [4 marks]

(c) In Algol, functions can be passed as arguments to functions but the type only mentions the result type of such a function formal parameter, whereas in ML more detail is given. Which is better, and why? [2 marks]

(d) Array types in object-oriented languages can be seen as generic classes having read and write operations. Java arrays are described as covariant. Contrast this with non-variant arrays in terms of compile-time versus run-time type errors. [2 marks]

(e) For each of the following ML declarations, either justify their ability to be soundly used or give a program using them which would violate type safety:

(i) exception poly of 'a; [1 mark]

(ii) val ml = ref []; [1 mark]

(f) Explain why the ‘private’ keyword is commonly available in object-oriented languages. Giving reasons, explain whether it is possible for the value of a private field of one object initialised by a parameterless constructor to be accessed from another object of the same class. [2 marks]