

COMPUTER SCIENCE TRIPOS Part IB – 2012 – Paper 3

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]