COMPUTER SCIENCE TRIPOS Part IB – 2015 – Paper 3

5 Concepts in Programming Languages (AM)

(a) Identify three programming or implementation concepts stemming from Algol or Fortran which are still mainstream ideas, noting whether they arose from Algol or Fortran. [3 marks]

(b) Give two comparable now-mainstream ideas, but excluding ideas directly involving typing, which arose other than from Algol and Fortran. [2 marks]

(c) At machine-code level, a structured value typically contains some form of tag indicating which of several variant forms the data may take (e.g. 'leaf' versus 'branch'); this determines how subsequent fields are to be interpreted (e.g. as pointers, strings or floating-point values).

    (i) Give code to show how type declarations in Java, ML and Pascal may be used to describe such structured values, following the above description as closely as possible. [5 marks]

    (ii) For one of your type declarations identify a source of type unsafety that can arise. [2 marks]

(d) What is the principal difference between statically typed and dynamically typed languages? Identify one early and one more modern statically typed language. Identify one early and one more modern dynamically typed language. [3 marks]

(e) What is the principal difference between type-safe and type-unsafe languages? Identify one type-safe language and one type-unsafe language, from any era. [2 marks]

(f) A downcast is a cast from a reference of a base class to a reference of one of its derived classes. Discuss the extent to which Java and C++ are statically typed and type-safe given that a downcast may fail at run-time. [3 marks]