1 Concepts in Programming Languages (am21)

(a) Algol-60 provided two parameter-passing mechanisms: call-by-value and call-by-name.

(i) Explain these mechanisms. [2 marks]

(ii) Justify or criticise the statement that “the former is expensive for arrays and the latter interacts badly with side effects”. [2 marks]

(iii) What parameter-passing mechanism(s) do C and Java use, and how do such languages deal with an array being passed as a parameter? [2 marks]

(b) A side-effect-free call-by-value language has its ML-like syntax of expressions \( e \) extended to be able to model call-by-name and (LISP-like) call-by-text:

\[
\begin{align*}
\text{e} & := \ldots | \text{suspend} \ e | \text{force} \ e \quad \text{(call-by-name)} \\
\text{e} & := \ldots | \text{quote} \ e | \text{eval} \ e \quad \text{(call-by-text)}
\end{align*}
\]

Both \text{suspend} \( e \) and \text{quote} \( e \) yield an unevaluated representation of \( e \) as a value for later evaluation by \text{force} and \text{eval} respectively. Sketch two programs (differing only in whether they use \text{suspend} and \text{force} or \text{quote} and \text{eval}) which give different results. [Note: Answers using side-effecting operators can only gain partial marks.]

[4 marks]

(c) A library defines a generic class \text{Foo}<\text{T}> in a Java-like language. A user’s program declares a class \text{C} and subclasses it as class \text{D}, creating variables \text{fc} and \text{fd} of types \text{Foo}<\text{C}> and \text{Foo}<\text{D}> respectively.

(i) Construct a declaration of \text{Foo}<\text{T}> along with a program of the above form containing the assignment \text{fc}=\text{fd} which, if this statement were legal, would be the cause of a later run-time error when executed. [5 marks]

(ii) How might the language syntax be changed to optionally express that the above assignment is to be allowed, indicating any compensating restrictions required for the declaration of \text{Foo}<\text{T}> or \text{fc} to avoid run-time errors. [3 marks]

(iii) How do Java arrays of type \text{T[]} fit in with your answer to Part (c)(i)? [2 marks]