COMPUTER SCIENCE TRIPOS Part IB – 2026 – Paper 4

1 Compiler Construction (jdy22)

The following ambiguous grammar G_1 describes nameless lambda calculus terms. (Familiarity with nameless lambda calculus is not assumed.)

`E` $\rightarrow$ `A` `E` $\rightarrow \lambda$ `E` `E` $\rightarrow$ `E A` `A` $\rightarrow n$ `A` $\rightarrow$ `( E )`

`E` is the start symbol, λ, n, `(` and `)` are terminals, and n stands for natural numbers (0, 1, 2, ...).

(a) Give an example of an *unambiguous* term that uses all the productions of G_1.

[2 marks]

(b) Give an example of an *ambiguous* term that uses all the productions of G_1.

[2 marks]

(c) Give two distinct leftmost derivations for your ambiguous term from Part (b).

[4 marks]

The ambiguity in G_1 is removed to give the following unambiguous grammar G_2:

`E` $\rightarrow$ `F` `E` $\rightarrow \lambda$ `E` `F` $\rightarrow$ `A` `F` $\rightarrow$ `F A` `A` $\rightarrow n$ `A` $\rightarrow$ `( E )`

(d) Show that G_2 is SLR(1). [6 marks]

(e) Show that G_2 is not LL(1). [2 marks]

(f) Give an LL(1) grammar for the language accepted by G_2, and sketch a proof that your grammar is LL(1). [4 marks]