## COMPUTER SCIENCE TRIPOS Part IB – 2012 – Paper 3

### 4 Compiler Construction (DJG)

(a) Define the following terms used when discussing a grammar:

    (i) a non-terminal symbol         [1 mark]

    (ii) an ambiguous grammar         [1 mark]

    (iii) a production         [1 mark]

    (iv) a context-free grammar         [2 marks]

    (v) a regular grammar         [2 marks]

(b) The following grammar defines a language where expressions are strings or integers. A type error arises when an integer is added to a string.

```
Var -> x | y
Exp -> Var | 0 | 1  | "cat" | "dog" | Exp + Exp
S   -> Var := Exp | S S
```

    (i) Give a syntactically-correct sentence of the language that contains a type error.         [1 mark]

    (ii) What phase (or pass) of a typical, simple compiler would detect such a type error? Sketch the fragment of code that actually spots the error.         [3 marks]

    (iii) Provide a modified grammar such that type errors are also syntax errors.         [3 marks]

    (iv) Why is such a modified grammar generally impractical?         [1 mark]

(c) Certain operators, such as **logical and**, which is commonly denoted with **&&** use short-circuit evaluation.

    (i) Define short-circuit evaluation.         [2 marks]

    (ii) Give two reasons why it is useful.         [1 mark]

    (iii) Describe the problem, and its solution, that arises when a short-circuit operator is encountered during a simplistic compilation of a syntax tree to stack machine code.         [2 marks]