

## CS\_218 COMPILERS

*(Attempt 2 questions out of 3)*

### Question 1.

- (a) For each of the following production rules state whether a grammar whose rules were all of the same format would be *context-sensitive*, *context-free*, or *regular*:

- i)  $X \rightarrow v$
- ii)  $X \rightarrow aY$
- iii)  $uXw \rightarrow uvw$

In each case letters in uppercase (X, Y) represent non-terminals and letters in lowercase (v, a, u, w) represent terminals.

[6 marks]

- (b) Explain, giving an example, what is meant by *left factoring* of a grammar production rule, and explain why you might want to do this.

[4 marks]

- (c) Draw a DFA state transition diagram which accepts strings in the regular language:  $(a|b)^*abb$

[5 marks]

- (d) Remove immediate left recursion from the following grammar:

$$\begin{aligned} A &\rightarrow Ab \mid Ac \mid d \\ B &\rightarrow Bc \mid e \end{aligned}$$

[6 marks]

- (e) State, in words and mathematically the two disjunctions necessary for a grammar to be LL(1).

[4 marks]

### Question 2.

- (a) Given the following grammar:

$$E \rightarrow E A E \mid (E) \mid - E \mid id$$

$$A \rightarrow + \mid - \mid *$$

give a *rightmost* and a *leftmost* derivation of the input string:

$$- ( id * id )$$

[6 marks]

- (b) Consider the following LL(1) grammar for simple arithmetic expressions :

$$E \rightarrow TG$$

$$G \rightarrow +TG \mid \varepsilon$$

$$T \rightarrow FR$$

$$R \rightarrow *FR \mid \varepsilon$$

$$F \rightarrow (E) \mid id$$

Compute *first* and *follow* sets for the grammar and then use these sets to create the parsing table.

[12 marks]

- (c) Let  $G = (T, N, S, P)$  be a context free grammar. Explain in detail each of the four components of  $G$ .

[7 marks]

### Question 3.

- (a) Draw, and carefully label, a diagram of the *analysis-synthesis* model of a compiler. Show clearly on your diagram which phases are considered to be the *front* and *back* ends of the model. Explain why the model is divided into a front and back end.

[6 marks]

- (b) Consider the following LR(0) grammar:

$$A \rightarrow ( A ) \mid a$$

Construct the set of *item state closures* and from that set create the LR(0) parsing table.

[12 marks]

- (c) State the conditions which must hold for a grammar to be LR(0). Explain the possible violations of this rule and the conflict which arises in each case.

[4 marks]

- (d) What is a suitable data structure for a *symbol table*? What information does a symbol table contain?

[3 marks]