

6 Formal Models of Language (fm611)

(a) Construct a context-free grammar that generates each of the following languages (and justify each answer):

(i) $L = \{a^n b^{n+m} a^m \mid n, m \geq 0\}$ [4 marks]

(ii) $L = \{w \in \{a, b\}^* \mid |w|_a = 2k, k \geq 0\}$ [4 marks]

(iii) $L = \{w \in \{a, b\}^* \mid |w| = 2k + 1, w_1 = w_{k+1}, k > 0\}$ [4 marks]

where $|w|$ denotes the length of string w , $|w|_a$ denotes the number of a symbols in w , and w_i denotes the i -th symbol in w .

(b) Consider the context-free grammar G with a single non-terminal symbol S and with the following production rules

$$S \rightarrow a S$$

$$S \rightarrow a S b S$$

$$S \rightarrow c$$

(i) Is the language generated by this grammar regular? Justify your answer. [5 marks]

(ii) Is this grammar ambiguous? Justify your answer. [3 marks]