



(c) Regular Expression over an alphabet  $\Sigma$

(d) Minimal DFA.

4. Let  $L = \{a^n b^n : n > 0\}$ . Construct an unambiguous CNF grammar that generates  $L$ . [15 points]

5. Let  $L$  be the language over  $\Sigma = \{a, b, c\}$  consisting of all strings with equal numbers of each symbol. Thus, for example,  $ababbacc \in L$ . Use the Pumping Lemma for context-free languages to prove that  $L$  is not context-free. [30 points]

6. Give a transition table or a state diagram for a 1-lookahead DPDA that accepts the language  $L$  generated by the context-free grammar whose start symbol is  $S$  and whose productions are:

$$S \rightarrow s$$

$$S \rightarrow AS$$

$$A \rightarrow aSb$$

[30 points]