Exercises from Section 13.1: (4), (5)

4. Let \( G = (V, T, S, P) \) be the phrase-structure grammar with \( V = \{0, 1, A, S\} \), \( T = \{0, 1\} \), and set of productions \( P \) consisting of \( S \rightarrow 1S, S \rightarrow 00A, A \rightarrow 0A, \) and \( A \rightarrow 0 \).
   a) Show that 111000 belongs to the language generated by \( G \).
   b) Show that 11001 does not belong to the language generated by \( G \).
   c) What is the language generated by \( G \)?

5. Let \( G = (V, T, S, P) \) be the phrase-structure grammar with \( V = \{0, 1, A, B, S\} \), \( T = \{0, 1\} \), and set of productions \( P \) consisting of \( S \rightarrow 0A, S \rightarrow 1A, A \rightarrow 0B, B \rightarrow 1A, B \rightarrow 1 \).
   a) Show that 10101 belongs to the language generated by \( G \).
   b) Show that 10110 does not belong to the language generated by \( G \).
   c) What is the language generated by \( G \)?

Exercises from Section 13.3: (11), (17), (19)

In Exercises 16–22 find the language recognized by the given deterministic finite-state automaton.

17. Start

19.
Solution for Section 13.1: (4)

4. **a)** It suffices to give a derivation of this string. We write the derivation in the obvious way. \( S \Rightarrow 1S \Rightarrow 11S \Rightarrow 111S \Rightarrow 11100A \Rightarrow 111000. \)

**b)** Every production results in a string that ends in \( S, A, \) or 0. Therefore this string, which ends with a 1, cannot be generated.

**c)** Notice that we can have any number of 1’s at the beginning of the string (including none) by iterating the production \( S \Rightarrow 1S. \) Eventually the \( S \) must turn into 00A, so at least two 0’s must come next. We can then have as many 0’s as we like by using the production \( A \Rightarrow 0A \) repeatedly. We must end up with at least one more 0 (and therefore a total of at least three 0’s) at the right end of the string, because the \( A \) disappears only upon using \( A \Rightarrow 0. \) So the language generated by \( G \) is the set of all strings consisting of zero or more 1’s followed by three or more 0’s. We can write this as \( \{ 0^n1^m \mid n \geq 0 \text{ and } m \geq 3 \}. \)