1. Read Kozen Sections 7–9.

2. Convert the following finite automaton with \( \epsilon \)-transitions to an equivalent deterministic finite automaton. What set does it accept? (\( \epsilon \)-transitions are marked “e” here.)

3. Recall that regular expressions are patterns over \( \emptyset, \epsilon, a \) for \( a \) in \( \Sigma \), and the operators +, concatenation, and \( * \).

   Give regular expressions for each of the following subsets of \( \{a, b\}^* \). Try to simplify the expressions as much as possible.
   
   (a) \( \{x \mid x \text{ contains an even number of } a\text{’s}\} \)
   
   (b) \( \{x \mid x \text{ contains an odd number of } b\text{’s}\} \)
   
   (c) \( \{x \mid x \text{ contains an even number of } a\text{’s or an odd number of } b\text{’s}\} \)
   
   (d) \( \{x \mid x \text{ every } b \text{ is immediately followed by at least 2 } a\text{’s}\} \)
   
   (e) Extra credit: \( \{x \mid x \text{ contains an even number of } a\text{’s and an odd number of } b\text{’s}\} \)

4. Give deterministic finite automata equivalent to the regular expressions

   (a) \( (0 + 1(010)^*1)^* \)
   
   (b) \( (01 + 10)^* \)

   Simplify the automata as much as possible.
5. Consider the regular sets denoted by the following pairs of regular expressions. For each pair, say whether the two sets are equal, and if not, give a string in one that is not in the other.

(a) \((a + b)^* \) \(a^* + b^*\)
(b) \(a(bca)^*bc \) \(ab(cab)^*c\)
(c) \(\emptyset^* \) \(e^*\)
(d) \((a^*b^*)^* \) \((a + b)^*\)
(e) \((ab + a)^*a \) \(a(ba + a)^*\)

6. Give a regular expression for the set of binary representations of multiples of four. Leading zeros are permitted and the null string represents zero.

7. Kozen Miscellaneous Exercise 27, p. 322. You need only give the informal and formal descriptions of an NFA, you need not prove the correctness of your construction. (For a hint and solution to a similar problem, see Miscellaneous Exercise 26. Your answer should address the questions outlined in steps 1 and 2 of the hint for Exercise 26.)