For each string below, indicate whether it is in the language represented by the automaton or not.

(a) aba
(b) cab
(c) abba
(d) c
(e) b
(f) abbcb
(g) ccba
(h) aaa
(i) cacb
(j) ccabb
2. Given the DFA $M = (\{q_0, q_1, q_2, q_3, q_4\}, \{a, b\}, \delta, q_0, \{q_4\})$, where $\delta$ is defined as:

<table>
<thead>
<tr>
<th>State</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q_0$</td>
<td>$q_1$</td>
<td>$q_2$</td>
</tr>
<tr>
<td>$q_1$</td>
<td>$q_1$</td>
<td>$q_4$</td>
</tr>
<tr>
<td>$q_2$</td>
<td>$q_1$</td>
<td>$q_3$</td>
</tr>
<tr>
<td>$q_3$</td>
<td>$q_4$</td>
<td>$q_3$</td>
</tr>
<tr>
<td>$q_4$</td>
<td>$q_4$</td>
<td>$q_4$</td>
</tr>
</tbody>
</table>

(a) Draw the DFA.
(b) Mark each of the following strings as Y if the string is accepted by M, and N otherwise.
   i. a
   ii. aa
   iii. bba
   iv. aab
   v. $\lambda$
   vi. ab
   vii. abba
   viii. babb
   ix. bbb
   x. abab

(c) Give an English description of the DFA.

3. Draw a finite automaton for each of the following:

   (a) A DFA for strings on $\{0, 1\}^*$ that end in 0.
   (b) A DFA for strings on $\{0, 1\}^*$ that contain the string 11.
   (c) $L = \{w \in \{a, b, c\}^* : \text{every a is followed by bc}\}$
   (d) $L = \{a^n b^m : n, m \geq 0 \text{ and } m + n \text{ is a multiple of 3}\}$

4. (a) Show that every finite language is regular.
   (b) Let $x$ be a string defined on the alphabet $\{0, 1\}$, where the length of $x$ is $n$.
   Describe a finite automaton that accepts the (single) string $x$ and no other strings.
   How many states are required? Give reasons for your answer.
   (c) Let $n$ be a positive integer and $L = \{w \in \{0, 1\}^* : |w| = n \text{ and } n_0(w) = n_1(w)\}$,
   where $n_0(w)$ is the number of 0’s in $w$, and $n_1(w)$ is the number of 1’s in $w$. What
   is the minimum number of states in a finite automaton that recognizes $L$? Give
   reasons for your answer.
5. Graduate students only. In the C programming language, all of the following expressions represent valid numerical “literals”:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>21</td>
<td>.123</td>
<td>21.57</td>
<td>+96.90</td>
</tr>
<tr>
<td>+0</td>
<td>-07</td>
<td>-4.67</td>
<td>1e13</td>
<td>+1.2e5</td>
</tr>
<tr>
<td>−2.e+8</td>
<td>01E−07</td>
<td>0.2E−16</td>
<td>−.4E−5</td>
<td>00e0</td>
</tr>
</tbody>
</table>

The letter e or E refers to an exponent, and if it appears, the number following it is an integer. Based on these examples, give a finite automaton representing the language of numeric literals. You can use a shorthand, e.g. d for digit, to make the size of the description more manageable. Assume that there are no limits on the number of consecutive digits in any part of the expression.