1. For each of the following languages, give a state diagram of a DFA that recognizes the language. For the first language $L_1$, also give the formal description of the DFA you construct. All languages are over the alphabet $\Sigma = \{0, 1\}$.

   (a) $L_1 = \{w | |w| \text{ is an integer multiple of 4}\}$ (recall that $|w|$ is the length of the string).
   (b) $L_2 = \{w | w \text{ is a representation of a binary number that is an integer multiple of 4}\}$.
   (c) (extra credit): $L_3 = \{w | w \text{ is a representation of a binary number that is an integer multiple of 3}\}$.
   (d) $L_4 = \{w | w \text{ does not contain the substring 110}\}$

2. Let $L_5 = \{w | \text{ the two symbols before the last one in } w \text{ are 01}\}$ (over the alphabet $\Sigma = \{0, 1\}$). For example, 11011 is in $L_5$ but 110111 is not in $L_5$.

   (a) Construct a DFA with 5 states for $L_5$.
   (b) Construct an NFA with 4 states for $L_5$.
   (c) Give the computation tree of your NFA from (b) on the word 01010.

3. For each of the following languages, give a state diagram of an NFA that recognizes the language. For the third language $L_8$, also give the formal description of the NFA you construct. All languages are over the alphabet $\Sigma = \{0, 1\}$.

   (a) $L_6 = \{0, 1\}$
   (b) $L_7 = \emptyset$
   (c) $L_8 = \{w | w \text{ contains an even number of 0s or exactly two 1s}\}$
   (d) $L_9 = \{w | w \text{ contains two 0s separated by a string } w' \text{ in } L_1\}$ where $L_1$ is the language defined in problem 1a above.