CS 4510: Automata and Complexity
Fall 2017
Homework 1 **Name:** _____
Due: Sep. 11th. 2017

This assignment contains 5 pages (including this cover page) and 4 questions. Print your name at the top of this page, and put your initials on the top of every other page, in case the pages become separated.

Please show your work on each problem. You might get partial credit for your work. Also, **do not write in the table below**.

Table for Instructor use only.

Question:	1	2	3	4	Total
Points:	25	15	20	25	85
Score:					

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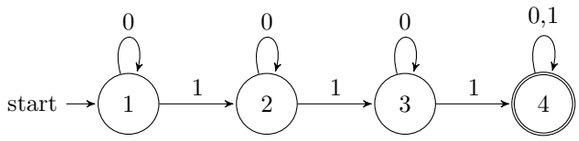
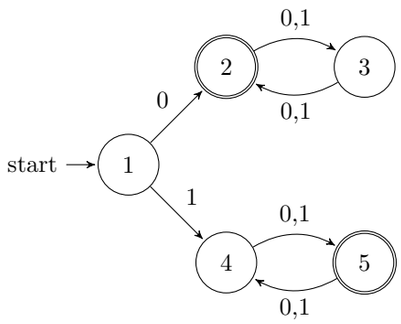
1. (25 Points) Give state diagrams of DFAs recognizing the follwing languages. In all parts, the alphabet is $\{0, 1\}$.
   (a) $\{w|w$ contains at least three 1s$\}$
   (b) $\{w|w$ starts with 0 and has odd length, or starts with 1 and has even length$\}$
   (c) $\{w|w$ doesn't contain the substring 110$\}$
   (d) $\{w|w$ is any string except 11 and 111$\}$
   (e) $\{w|w$ contains an even number of 0s, or contains exactly two 1s$\}$

Answers

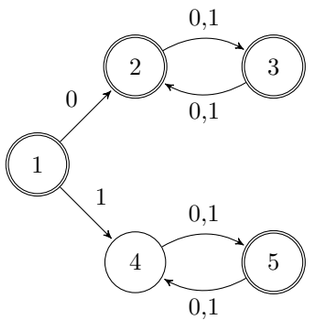
(a)



(b)



(c)



2. (15 Points) Give state diagram of NFAs with the specified number of states recognizing each of the following languages. In all parts, the alphabet is $\{0, 1\}$

   (a) $\{w|w$ contains the substring 0101 (i.e., $w = x0101y$ for some x and $y)\}$

   (b) $\{w|w$ contains an even number of 0s, or contains exactly two 1s$\}$

   (c) The language $0^*1^*0^+$ with three states

3. (20 Points) Please complete following proofs.

   (a) Show that if M is a DFA that recognizes language B, swapping the accept and nonaccept states in M yields a new DFA recognizing the complement of B. Conclude that the class of regular languages is closed under complement.

   (b) Show by giving an example that if M is an NFA that recognizes language C, swapping the accept and nonaccept states in M doesn't necessarily yield a new NFA that recognizes the complement of C. Is the class of languages recognized by NFAs closed under complement? Explain your answer.

4. (25 Points) Complete the five levels of Manufactoria (http://pleasingfungus.com/Manufactoria/) circled in red in the image below.

    1. For each of your solutions, click the "Save" button (floppy disk icon), and copy the URL it gives you. (Note: Save is not available until after you complete level 1.)
    2. Submit the URLs to your solutions on T-square.
    3. Answer what does this game have to do with the material we study?

    For clarity, the levels you will be submitting are:

    - **Robotoast**! ACCEPT: Move robots from the entrance (top) to the exit (bottom)!
    - **Robocoffee**! If a robot's string starts with blue, accept. Otherwise, reject!
    - **Robolamp**! ACCEPT: if there are three or more blues!
    - **Robofish**! ACCEPT: if a robot contains NO red!
    - **Robobugs**! ACCEPT: if the tape has only alternating colors!