Due September 28

1. Using the method from class, give an NFA that recognizes $L_1^*$, where $L_1$ is the language from Exercise 3(a) of Homework 2.

2. Give regular expressions for the following languages:
   (a) $\{w \in \{0, 1\}^* | w \text{ starts with either 010 or 11}\}$
   (b) $\{w \in \{0, 1\}^* | w \text{ contains exactly one 1 and an even number of 0's}\}$
   (c) $\{w \in \{0, 1\}^* | w \text{ does not contain 10}\}.
   $d) $\{w \in \{0, 1\}^* | w \text{ does not start with 010 and does not start with 11}\}.$

3. Convert the regular expression $a(b \cup c)^*$ into an NFA using the method from class (which is the same as the method from the book and is different from the method in JFLAP).

4. Convert the NFA in Figure 1.36 of the textbook into a regular expression using the method from class (which is the same as the method in the book, and is not the same as the method in JFLAP).

5. Problem 1.31

6. Use the Pumping Lemma to show that the following languages are not regular:
   (a) $\{0^n1^{2n} | n \geq 0\}$;
   (b) $\{0^n1^m | n < m\}$
   (c) $\{w\# | w, u \in \{0, 1\}^* \text{ and } |w| > |u|\}$
   (d) $\{x_1\#x_2\#x_3 | x_1, x_2, x_3 \in \{a, b\}^* \text{ and either } x_3 = x_1^R \text{ or } x_3 = x_2^R\}$.

7. (a) Let $M$ be the NFA given in the solution to Problem 3(b) on Homework 2. Give an NFA $N$ with two states and no $\varepsilon$-transitions that recognizes the same language.
   (b) Generalize what you did in Part (a) of this problem by proving the following theorem:
   **Theorem:** If $M$ is an NFA, then there is an NFA $N$ with the following properties
   (1) $N$ has the same number of states as $M$.
   (2) $N$ has no $\varepsilon$-transitions.
   (3) $L(N) = L(M)$. 