15-453: Formal Languages, Automata, and Computability **L. Blum**
Homework #2 **Due Date: January 28, 2014**

Rules: Collaborate as you like, but everyone must write up their own solutions. Cite all references that you use (books, people, yourself) at the end of your writeup. All proofs should contain: (1) a one-line phrase with your proof strategy, (2) an informal paragraph outlining your idea, and (3) the gritty details. Be as precise and rigorous as you can! Please print out the solutions to each problem on a separate sheet of paper.

1

Give regular expressions for the following languages.

(a) $\{x \in \{a, b, c\}^* \mid x$ contains the substring "cab"$\}$.

(b) $\{x \in \{a, b, c\}^* \mid x$ contains an even number of b's$\}$.

(c) $\{x \in \{a, b, c\}^* \mid x$ every a in x is followed by a b, and x ends with a $c\}$.

2

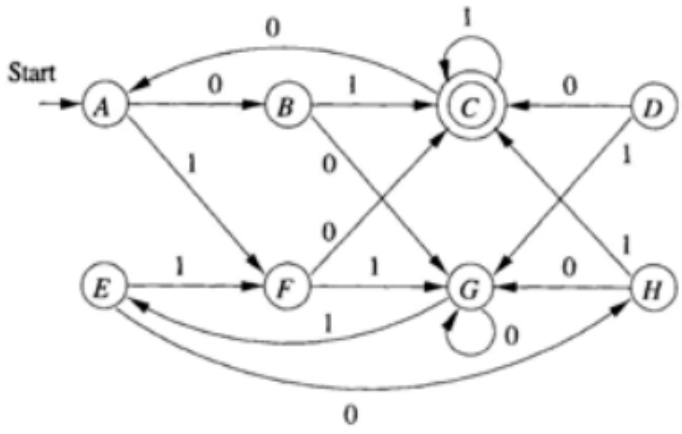
Draw NFAs for the following regular expressions.

(a) `((ab)*(aba|aab)+)*`

(b) `((ab|ba)|(aab)*)*`

3

Minimize the following DFA. Show all the steps of the minimization algorithm.



4

Use the Pumping Lemma to prove that the following strings are not regular.

(a) The language of strings in $\{0,1\}^*$ containing exactly 3 more 0s than 1s.

(b) The language of strings in $\{0,1,2\}^*$ of the form $0^m 1^{m+n} 2^n$.

5

Include a References section. Cite all sources that you used and people, including yourself, that you collaborated with on this homework.