Ph.D. Qualify Examination 2017
Theory of Computation

- This examination is closed books.
- Please turn off your cell phones.
- Remember that there are 2 pages of the qualify examination.
- Answer all questions as possible. You may have a partial score if you answer the correct direction.

1. Deterministic Finite Acceptor (DFA) (10 pts)
Draw Deterministic Finite Automata to accept the set of all strings over {a, b} that do not contain the substring "aab".

2. Nondeterministic Finite Acceptor (NFA) (10 pts)
All strings where every odd position is "b".

3. Convert the nfa defined by
$\delta(q_0, a) = \{q_0, q_1\}$
$\delta(q_1, b) = \{q_1, q_2\}$
$\delta(q_2, a) = \{q_2\}$
$\delta(q_0, \lambda) = \{q_2\}$
with initial state q_0 and final state q_2 into an equivalent dfa. (10 pts)

4. Determine whether or not the following language on $\Sigma = \{a, b, c\}$ is regular: (10 pts)
$L = \{a^n b^k c^n : n \geq 0, k \geq 0\}$.

5. Show that the following grammar is ambiguous. (10 pts)
$S \rightarrow aSbS|bSaS|\lambda$.

6. Prove that all finite languages are regular. (10 pts)

7. Construct a nondeterministic pushdown automata that accepts the following language on $\Sigma = \{a, b\}$: (10 pts)
$L = \{a^n b^{3n} : n \geq 0\}$.

8. Find an nfa that accepts the language $L(aa^*(ab + b))$. (10 pts)

9. Fill the following languages into the language hierarchy (If L_i is a regular language and also a context-free language, please fill L_i in the set of regular languages): (20 pts)
$L_1 = L(a^*b^*a^*)$,
$L_2 = \{a^2 b^n c^n : n >= 0\}$,
$L_3 = \{ab, ad, ac, b, cd\}$,
$L_4 = \{a^n w w^R a^n : n \geq 0, w \in \{a, b\}^*\}$,
$L_5 = \{a^n b^n c^n : n \geq 0\}$,
$L_6 = \{ww : w \in \{a, b\}^*\}$,
$L_7 = \{a^{n!} : n \geq 0\}$,
$L_8 = \{a^n b^m : n \geq m\}$,
$L_9 = \{a^n b^m c^{n+m} : n \geq 0, m \geq 0\}$,
$L_{10} = \{a^n b^j a^j b^n : n \geq 0, j \geq 0\}$.