Automata and Formal Languages

Final

Name

900\_\_\_\_\_\_\_\_\_\_\_\_

Total: 75 points

Finals is to be done individually

You may use notes from class, lectures and other resources that are posted and the textbook.

You may not google for answers, or clarifications for questions

If you have any question whatsoever , please email me directly.

1. *(1 point 1 min)* What is an alphabet
2. *(1 point 1 min)*What is a language
3. *(1 point 1 min)*Give the inductive definition of regular expressions over {a, b} (i.e., what constitutes a regular expression)
4. *(1 point 1 min)*What is the configuration of a machine? DFA? PDA?
5. *(1 point 1 min)*Give the pumping lemma for regular languages
6. *(1 point 1 min)*Give the pumping lemma for context free languages
7. *(1 point 1 min)*State the halting problem
8. *(1 point 1 min)*Can a Context free language be regular? Can a context free language be non-regular?
9. *(1 point 1 min)*Can a regular language be context free? Can a regular language be non-context free?
10. *(1 point 1 min)* Can a regular language be non-context free? Can a non-regular language be context free?
11. *(10 point 10 min)* (a) Consider a language of strings over {1} such that the string read as a unary number is a power of 2. Is this language regular or not? If regular, give the DFA. If non-regular, show that using pumping lemma.

(b)Consider a language of strings over {0,1} such that the string read as a binary number is a power of 2. Is this language regular or non-regular. If regular, give the DFA. If non-regular, show that using pumping lemma

1. *(5 point 5 min)*Consider the following grammar that defines Boolean expressions over Boolean constants t and f. Nonterminals = {E}; Terminals = {t, f, ∧, ∨ }. Production rules are: “E 🡪 t | f | E ∧ E | E ∨ E“. Give all possible parse trees for “t ∧ t ∨ f”.
2. *(3 point 3 min)* Is the language generated by the grammar in Q12 regular? If yes, give a rex/dfa; if no prove using pumping lemma
3. *(7 point 7 min)* Assuming ∧ has precedence over ∨, and both operators associate to the right, give an unambiguous grammar for Boolean expressions over t, f, ∧ and ∨,
4. *(3 point 3 min)* For the grammar you gave in Q14, give all possible parse trees for “t ∧ t ∨ f”
5. *(2 point 2 min)* How would you modify your answer for Q13 for the language generated by the grammar you gave in Q14?

1. *(3 point 3 min)* Given a DFA that accepts a language L, how will you modify it to accept ~L? Why can the same method not be used with a PDA?
2. *(7 point 7 min)* (a)Construct a DFA for a\*b\*. (b) Then use the method you gave in Q17 to get a DFA that accepts the complement of this language. (c) Find the REX corresponding to this DFA using state elimination.
3. *(10 point 10 min)* Run the CYK algorithm for the following grammar using input “aaabbb”

S 🡪 AT | AU | epsilon

T 🡪 UB | b

U 🡪 AT | UT

A 🡪 a

B 🡪 b

1. *(5 point 5 min)* Write a Turing machine that gets a binary number as an input, and if the number is even adds one to it, and if the number is odd, subtracts one from it. You would need just a one cursor, one tape, one way tape machine; give the full machine, not just the algorithm
2. (extra credit) *(5 point 5 min)* If the answer to this question (Q21) were to be randomly guessed, what is the probability that the correct answer will be guessed?
   1. 1/3
   2. 1/3
   3. 2/3

Explain your answer

1. *(10 minutes 10 points)* Minimize the following DFA

