Midterm Exam 2
CS 611: Theory of Computation

Mar 21, 2022 2:45-4:00pm (in class)

Instructions:

1. This is an open-note exam, you can bring a note written on a A4 paper with you, double sided is fine, and you will write down your name and NetID on the note and turned it in together with the exam.
2. You have 75 minutes to solve this exam, scan and submit your answers to Blackboard.
3. Please clearly write down your answers, points deducted due to unreadable writing will be fully your responsibility.
4. Make your answer concise, e.g., when 4 states is enough for a PDA, then no need to draw 5 states.

Name	
NetID	

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Problem	Maximum Points	Points Earned
Notes	10	
1	40	
2	20	
3	30	
Total	100	

Problem 1. Give the Context-Free Grammar that recognize the following languages. You don't need to prove your grammar is correct.

1. $L_1 = \{0^i 1^j 2^k \mid i, j, k \geq 0, i + j = k\}$ where $\Sigma = \{0, 1, 2\}$.
   Hint: Thinking about two languages concatenated together to form L_1. **[20 points]**

2. $L_2 = \{w\#z \mid w^R \text{ is a substring of } z\}$ with $\Sigma = \{0, 1\}$. **[20 points]**
   Hint: You can think of $z = xw^Ry$ where $x, y \in \{0, 1\}*$, then strings that is in L_2 would be in the format of $w\#xw^Ry$. You can use one variable to generate x and y (they are just any binary strings), then one variable to generate $w\#xw^R$ think about palindrome, only the base case starts with $\#x$; then finally a start symbol to generate

Problem 2.

Design a PDA to recognize the language over $\Sigma = \{0, 1\}$, $L_3 = \{w\#z \mid z^R \text{ is a substring of } w\}$. **[20 points]**

Problem 3.

1. State Pumping Lemma for CFLs. **[5 points]**

2. Prove that $L_3 = \{0^n 1^{2m} 0^n 1^{2m} | m, n \geq 0\}$ is not context free using pumping lemma. **[25 points]**