CS 3823 - Theory of Computation: Homework Assignment 3

Fall 2025 **Due:** Tuesday, November 4, 2025

Related Reading. Sections 3.3, 4.3, 5.1, 5.2, 6.1, 6.2, 7.1
Instructions. Near the top of the first page of your solutions please list clearly **all** the members of the group (please see the syllabus for the collaboration policy) who have created the solutions that you are submitting. Listing the names of the people in the group implies their full name and their 4x4 IDs. Alternatively, you can use the space below and provide the relevant information in case you submit the solutions using this document.

Student Information for the Solutions Submitted

	Lastname, Firstname	4x4 ID (e.g., dioc0000)
1		
2		
3		
4		
5		
6		

Grade

Exercise	Pages	Your Score	Max
1	2-3		10
2	4		5
3	5		5
4	6-7		10
5	8-9		10
Total	2-9		40

Additional Help and Resources. Did you use help and/or resources other than the textbook? Please indicate below.

1 JFLAP [10 points]

Let the alphabet be $\Sigma = \{0, 1\}$ in every case below. Use JFLAP (http://www.jflap.org) to implement and test state machines. Include in each of your answers a **screenshot** that shows how each automaton looks like inside JFLAP, as well as **examples** of their execution **on some input strings**.

(i) **[5 pts]** Give a **DFA** recognizing the language $L_{1,a} = \{w \mid w \text{ is any string except 11 and 111}\}$.

(continuation of exercise 1)

(ii) **[5 pts]** Give an **NFA** recognizing the language $L_{1,b} = (01 \cup 001 \cup 010)^*$.

2 Beating a Finite Automaton in the Big Match [5 points]

This exercise is based on the paper *Beating A Finite Automaton in the Big Match*, by Lance Fortnow and Peter Kimmel. The paper is available at:

http://www.tark.org/proceedings/tark_jul22_98/p225-fortnow.pdf.

Please read the introduction and the preliminaries of this paper up to page 4 where the definition of "The Big Match" is given. Then jump to Section 3 and read Theorems 3.1 and 3.2 (with their proofs).

(i) **[3pts]** In the course we are using an idea similar to the one that is used in the proof of Theorem 3.1. What is that idea or theorem that we prove in class?

(ii) **[2pts]** Why does this idea fail to provide a positive result in Theorem 3.2?

3 Regular Grammars [5 points]

Let $\Sigma = \{0, 1\}$. Find a regular grammar that generates the languange L shown below:

$$\mathsf{L} = \{w \mid w \in \Sigma^* \text{ such that } w \text{ has at most two 0's}\} \ .$$

4 Context-Free Grammars [10 points]

Consider the context-free grammar G_2 shown below.

$$\begin{array}{lcl} \mathsf{S} & \longrightarrow & \mathsf{0X} \\ \mathsf{X} & \longrightarrow & \mathsf{0X} \\ \mathsf{X} & \longrightarrow & \mathsf{1X} \\ \mathsf{X} & \longrightarrow & \mathsf{1} \end{array}$$

(i) **[3 pts]** What language does G_2 recognize?

(ii) **[2 pts]** Is $\mathsf{L}(\mathsf{G}_2)$ regular? Why or why not?

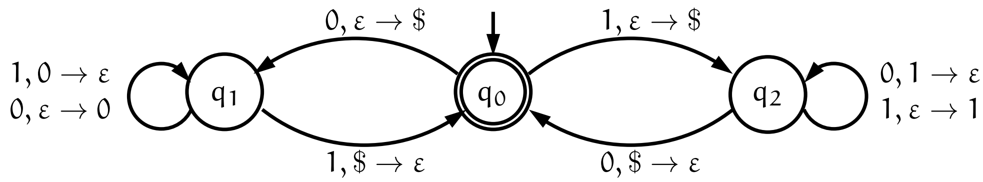
(iii) **[3 pts]** Give a CFG in Chomsky Normal Form generating $\mathsf{L}(\mathsf{G}_2)$.

(iv) **[3 pts]** Is your CFG that you gave in the question above ambiguous? Why or why not?

(extra space in case you need it for exercise 4)

5 Pushdown Automata [10 points]

Let P_3 be the PDA that is shown below.



(i) **[2 pts]** Give a formal description of P_3.

(ii) **[3 pts]** What language does P_3 recognize?

(iii) **[3 pts]** Give a context-free grammar that generates $L(P_3)$.

(iv) **[2 pts]** Is $L(P_3)$ regular? Why or why not?

(extra space in case you need it for exercise 5)