

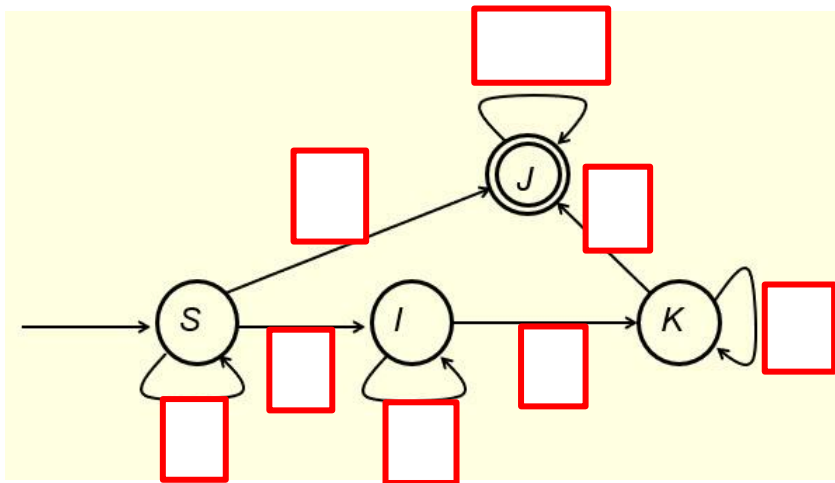
CS375 Homework Assignment 4-2 (19 points)

Due date: 10/09/2026

1. Given the following regular grammar:

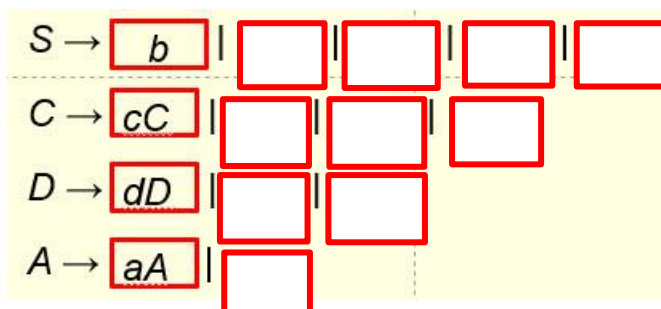
$$S \rightarrow aS \mid aI \mid bJ, \quad I \rightarrow bK \mid aI, \quad K \rightarrow aK \mid bJ, \quad J \rightarrow aJ \mid bJ \mid \Lambda$$

one can use the algorithm given in slide 39 of the notes “Regular Languages and Finite Automata- IV” to construct an NFA to recognize the language of that grammar. Fill out **blanks** in the following figure so that the resulting NFA would fulfill such a task, i.e., would recognize the language of the given grammar. (4 points)



2. Fill out the following blanks to make it a regular grammar with S being the start symbol for the following given regular expression:

$$c^*d^*a^* + b \quad (5 \text{ points})$$



3. Using **Pumping Lemma** (slides 46-52 of the notes ‘Regular Languages & Finite Automata- IV’) one can show that the language $L = \{a^n b^n \mid n \in \mathbf{N}\}$ is not regular (We need this property in the next Chapter). This is done by way of contradiction. We assume L is regular. Since L is infinite, Pumping Lemma applies. We then consider the string $s = a^m b^m$ where m is

the number of states in the DFA that recognizes L . Since the length of s is bigger than m , by Pumping Lemma, there exists strings x, y and z such that $s = xyz$, $y \neq \Lambda$, $|xy| \leq 2m$ and $xy^kz \in L$ for all $k \in \mathbb{N}$. If $|xy| < 2m$ then the first repeated state on the acceptance path cannot be a final state. This statement is not true, why? (2 points)

4. Fill out the following blanks to make it a context-free grammar for the given language over the alphabet $\{a, b\}$: $\{a^{2n+3}b^{3n} \mid n \geq 0\}$ (2 points)

$S \rightarrow$ $|$

5. Fill out the following blanks to make it a context-free grammar for the given language: $\{a^{n+3}b^{2n} \mid n \geq 0\} \cup \{a^{2n}b^{n+3} \mid n \geq 0\}$ (2 points)

$S \rightarrow AB, \quad A \rightarrow$ $|$, $B \rightarrow$ $|$

6. For the PDA's shown in Fig. 1 and Fig. 2, which one/ones or no one would accept the language $L = \{x \in \{a, b\}^* \mid N_a(x) = 1 + N_b(x)\}$ by empty stack? Use the execution of the string $babaa$ to justify your answer. You need to create/use your own text boxes for your work in the tables. (4 points)

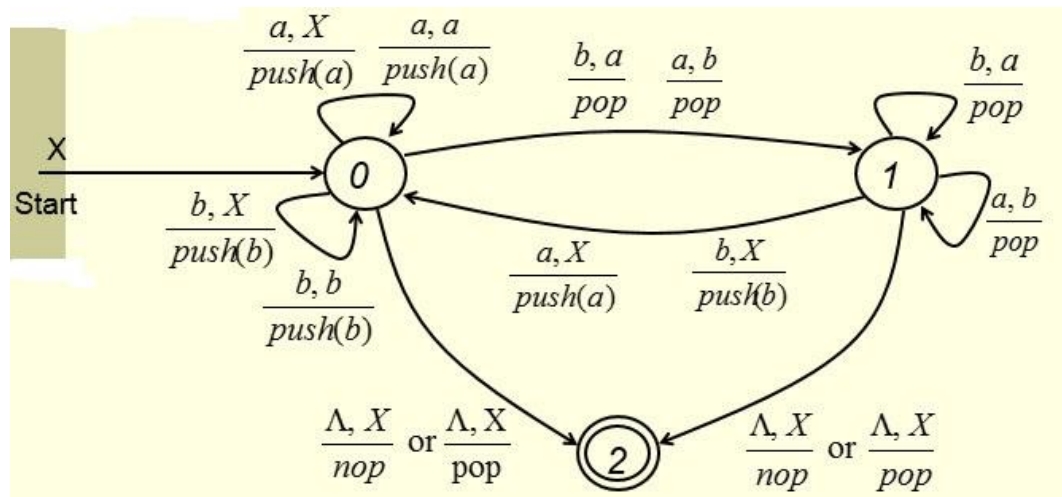


Fig. 1

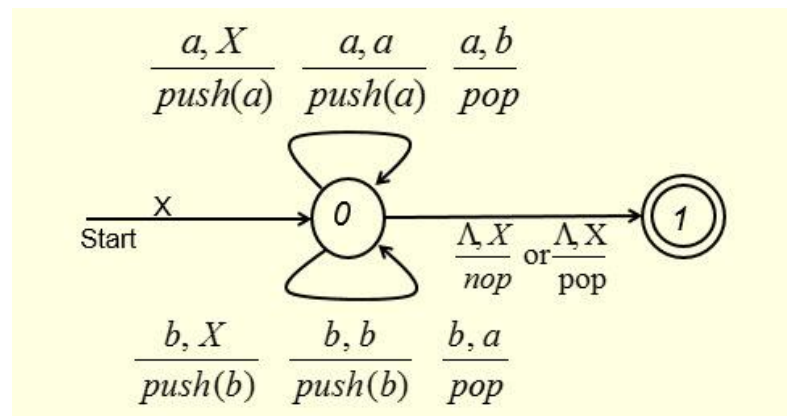


Fig. 2

Sol.

For the PDA in Figure 1, we have

[illegible]

For the PDA in Figure 2, we have

[illegible]

- Solutions must be typed (word processed) and submitted both as a pdf file and a word docx file to Canvas before 23:59 on 10/09/2026.
- Don't forget to name your files as

CS375_2026f_HW4-2_LastName.docx / CS375_2026f_HW4-2_LastName.pdf