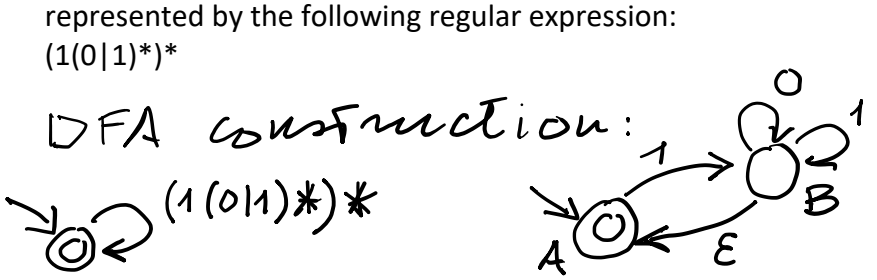
Formal Languages and Compilers Theory test July 03, 2023

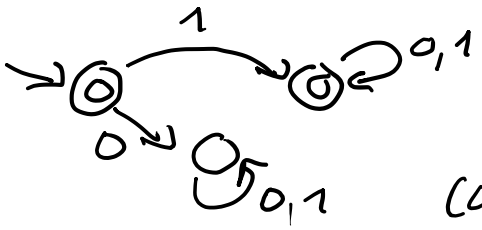
1. (9 points) Find a regular expression that represents the complement of the language represented by the following regular expression:
   (1(0|1)*)*

DFA construction:



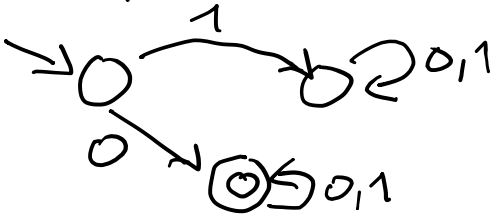
ε-NFA

	0	1
→* {A}	{}	{A,B}
*{A,B}	{A,B}	{A,B}
{}	{}	{}



DFA (completely specified)

Complement DFA:



Regexp: **0 (0|1)***

2. (8 points) Find a PDA that accepts the language of all the strings taking the form $a^n b^k a^m$ with n>0, k>0, m>0, and n+m=k.

$a^n b^k a^m \quad n>0, k>0, m>0, n+m=k$

$\Downarrow$

$a^n b^{n+m} a^m \quad n>0, m>0$

$\Downarrow$

$\underbrace{a^n b^n}_{A} \underbrace{b^m a^m}_{B} \quad n>0, m>0$

CFG:

$S \to AB$
$A \to aAb \mid ab$
$B \to bBa \mid ba$

PDA: $(\{q\}, \{0,1\}, \{0,1,S,A,B\}, \delta, q, S, \Phi)$

with
$\delta(q,\varepsilon,S) = \{(q, AB)\}$
$\delta(q,\varepsilon,A) = \{(q, aAb), (q, ab)\}$
$\delta(q,\varepsilon,B) = \{(q, bBa), (q, ba)\}$
$\delta(q,a,a) = \delta(q,b,b) = \{(q,\varepsilon)\}$

3. (9 points) Build the SLR parsing table for the following grammar whose set of terminal symbols is { x , *, < , > } and whose start symbol is S

S → A | A * S | ε (1, 2, 3)
A → < B > (4)
B → x | x * B (5, 6)

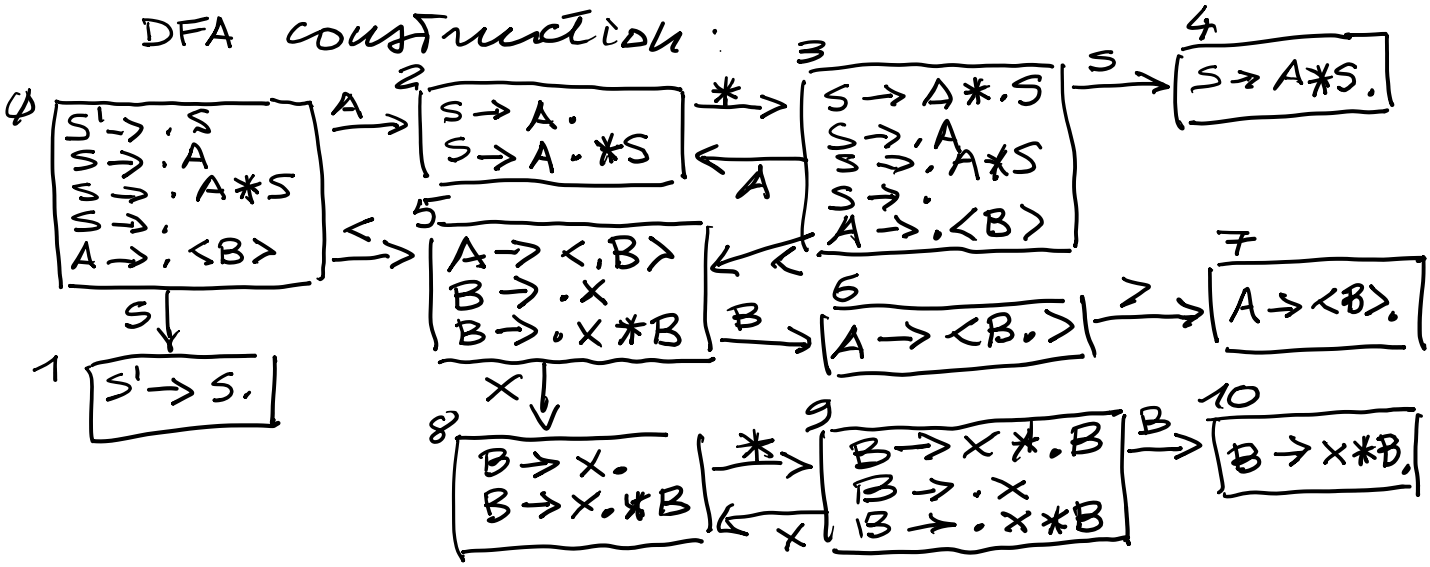
Tell if this grammar is SLR or not. Motivate your answer.

Add new non-terminal S' and rule S' → S (0)

Computation of nullable, FIRST, FOLLOW:

	nullable	FIRST	FOLLOW
S	T	<	$
A	F	<	*, $
B	F	x	>

DFA construction:



SLR Parsing Table:

	x	*	<	>	$	S	A	B
0			s5		r3	1	2	
1					acc			
2		s3			r1			
3			s5		r3	4	2	
4					r2			
5	s8							6
6				s7				
7		r4			r4			
8		s9		r5				
9	s8							10
10				r6				

The grammar is SLR because the SLR parsing table has no conflict.

4. (6 points) What is the difference, in terms of computational complexity, between the membership problem for context-free languages and the membership problem for deterministic context-free languages?

The time complexity of the membership problem for context-free languages is cubic in the length of the input string, while for deterministic context-free languages it is linear in the length of the input string.