Formal Languages and Compilers Theory test July 22, 2024

1. (8 points) Verify the equivalence of the regular expression a* b ((a a* b) | b)* and the grammar G=({S,A},{a,b},P,S), with
   P = { $S \rightarrow aS \mid bA \mid b$,
   $A \rightarrow bA \mid aS$ }.

2. (8 points) Write the definition of a context-free grammar that generates the following language: { $0^i\ 1\ 0^j\ 1^k \mid 0 \leq i \leq j$, $j \geq 0$, $k \geq 1$ }.

3. (10 points) Build the LALR(1) parsing table for the following grammar (where S is the start symbol, and the set of terminal symbols is {0,1})

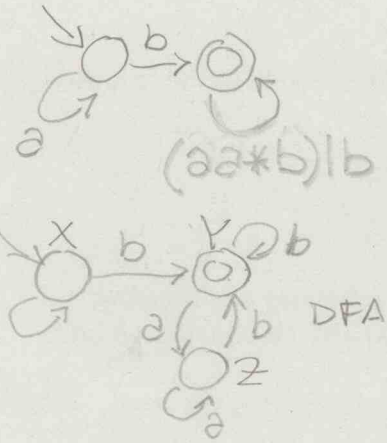
   $S \rightarrow AB$
   $A \rightarrow 0B1 \mid \varepsilon$
   $B \rightarrow 1A0$

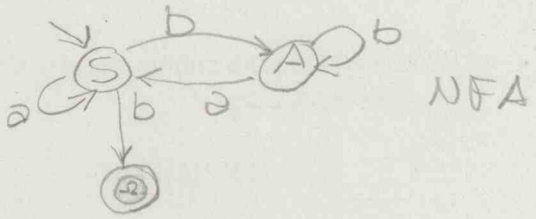
   Tell if the grammar is LALR(1), and motivate your answer.
   Tell if the grammar is LR(1), and motivate your answer.
   Based on the previous results, is it possible to tell if the language generated by the grammar is deterministic? Explain why.

4. (6 points) What is the relation between recursively enumerable sets and recursive sets? What is the relation between recursively enumerable sets and type 0 languages?

(1) Verify equivalence of

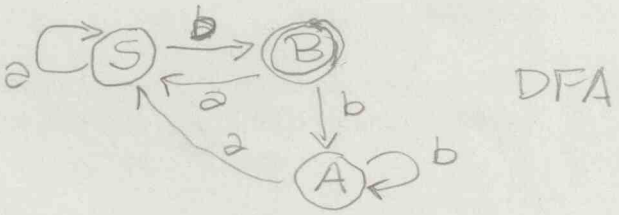
$a^*b\,((aa^*b)|b)^*$ and $S \to aS \mid bA \mid b$, $A \to bA \mid aS$





Building DFA

	a	b	
→ {S}	{S}	{A, Σ}	B
* {A, Σ}	{S}	{A}	
{A}	{S}	{A}	



Π_0 : {X, Z, S, A}, {Y, B}

Π_1 : {X, Z, S}, {A}, {Y}, {B}

Π_2 : {X, Z}, {S}, {A}, {Y}, {B}

NOT equivalent

(2) $\{0^i 1 0^j 1^k \mid 0 \leq i \leq j,\ j \geq 0,\ k \geq 1\}$

$S \rightarrow AB$

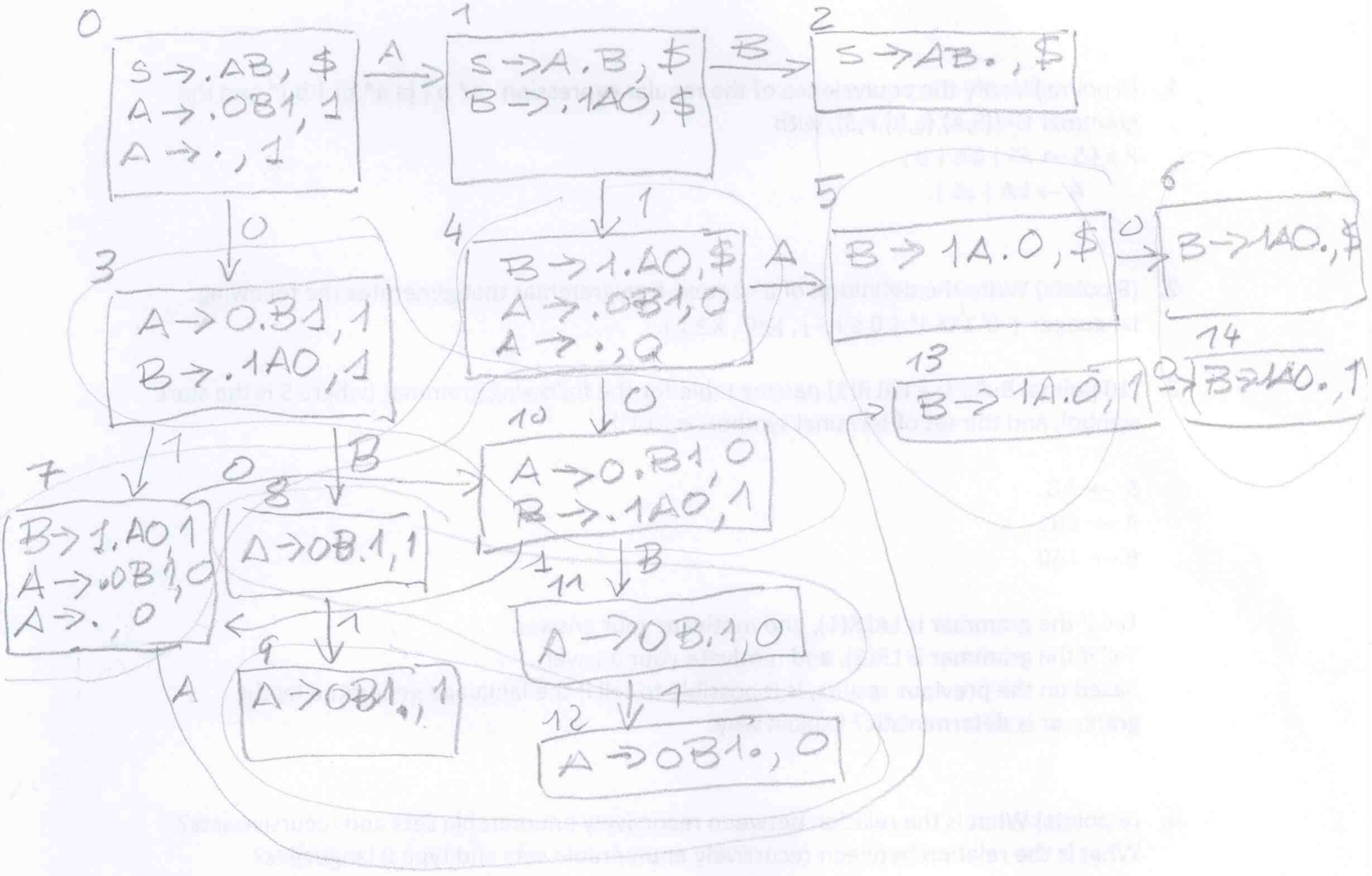
$A \rightarrow 0A0 \mid A0 \mid 1$

$B \rightarrow 1B \mid 1$

(3)

S → AB	0
A → 0B1 | ε	1,2
B → 1A0	3

	NULLABLE	FIRST	FOLLOW
S	F	0,1	$
A	T	0	0,1
B	F	1	1,$



	0	1	$	S	A	B
0	s3_10	r2			1	
1		s4_7				2
2			acc			
3_10		s4_7				8_11
4_7	s3_10/r2				5_13	
5_13	s6_14					
6_14		r3	r3			
8_11		s9_12				
9_12	r1	r1				

No, the grammar is not LALR(1) because of the s/r conflict in state 4_7 with symbol 0.
The grammar is not LR(1) because the same conflict occurs in the LR(1) parsing table too.
No, it is not possible to tell because there could be a LR(1) grammar for the same language

(4) Recursive sets are a subset of recursively enumerable sets.
Recursively enumerable sets are type-0 languages
(they are the same)