Tuesday 12/04/2022 | Midterm Exam | Duration: 90 minutes

Name: | Student No:

P1 [25 points]

1. Compute the weakest precondition for each of the following sequences of assignment statements and their postconditions: (5p each)

   (a)
   ```
   a = 2 * b + 1;
   b = a - 3
   {b < 0}
   ```
   b<1 a<3 (5)

   (b)
   ```
   a = 3 * (2 * b + a);
   b = 2 * a - 1
   {b > 5}
   ```
   2b+a>1 (5) a>3

2. Write a single regular expression for numbers including integers (5, 0, -3, etc.) and floating numbers(7.2, -0.3, etc.). (5p) -?([1-9][0-9]* | 0)[. [0-9]+]? (5)

3. Do regular expressions $b^+a^*b^*$ and $b^*a^*b^+$ generate the same language? (2p) Justify your answer. (5p)

   No. (2) $ba \in b^+a^*b^*$ but $ba \notin b^*a^*b^+$ (3)

4. Do regular expressions $a^*b^+a^*b^*a^*$ and $a^*b^*a^*b^+a^*$ generate the same language? (2p) Justify your answer. (5p)

   Yes (2) because if ∃ two b series ⇒ $a^*b^+a^*b^+a^* \subseteq$ both
   if ∃ one " " ⇒ $a^*b^+a^* \subseteq$ both, too. (3)

P2 [20 points] Consider the following grammar and find out which of the following strings are in the language generated by this grammar? (Circle correct options.)

$\langle S \rangle \rightarrow \langle A \rangle a \langle B \rangle b$

$\langle A \rangle \rightarrow \langle A \rangle a \mid b$ b[aaa..]

$\langle B \rangle \rightarrow \langle B \rangle b \mid a$ a[bbb..]

~~aababbab~~	Yes	(No) 5
~~abab~~	Yes	(No) 5
~~baba~~	Yes	(No) 5
baaaabb	(Yes)	No

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has to start with b. always end with b.

P3 [30 points] Consider the following grammar:

⟨S⟩ → ⟨S⟩ + ⟨S⟩ | ⟨id⟩

⟨id⟩ → a | b | c

a. Write a leftmost derivation for the string c+b+a

⟨S⟩ → ⟨S⟩ + ⟨S⟩
→ ⟨S⟩ + ⟨S⟩ + ⟨S⟩
→ ⟨id⟩ + ⟨S⟩ + ⟨S⟩
→ c + ⟨S⟩ + ⟨S⟩
→ c + ⟨id⟩ + ⟨S⟩
→ c + b + ⟨S⟩
→ c + b + ⟨id⟩
→ c + b + a.

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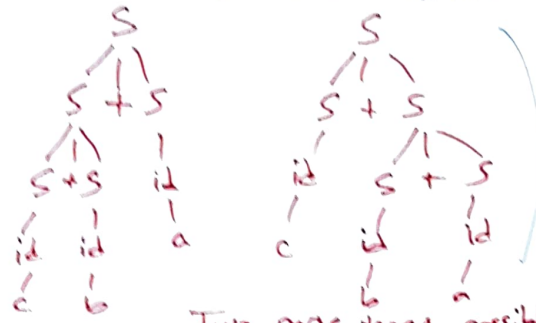
b. Prove that the grammar is ambiguous.



Two parse trees possible ⇒ ambiguous.

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c. Modify this grammar so that it is no longer ambiguous.

⟨S⟩ → ⟨S⟩ + ⟨id⟩ | ⟨id⟩

⟨id⟩ → a | b | c

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P4 [25 points] Consider the grammar and the corresponding LR parsing table from the textbook. Write the trace of a parse of the string id+(id)

1. E → E + T
2. E → T
3. T → (E)
4. T → id

State	Action					GoTo	
	id	+	(	)	$	E	T
0	S4		S3			1	2
1		S5			accept		
2	R2	R2	R2	R2	R2		
3	S4		S3			6	2
4	R4	R4	R4	R4	R4		
5	S4		S3				8
6		S5		S7			
7	R3	R3	R3	R3	R3		
8	R1	R1	R1	R1	R1		

Stack	Input	Action	
0	id+(id)$	S4	2
0 id 4	+(id)$	R4	2
0 T 2	+(id)$	R2	2
0 E 1	+(id)$	S5	2
0 E 1 + 5	(id)$	S3	2
0 E 1 + 5 (3	id)$	S4	2
0 E 1 + 5 (3 id 4	)$	R4	2
0 E 1 + 5 (3 T 2	)$	R2	2
0 E 1 + 5 (3 E 6	)$	S7	2
0 E 1 + 5 (3 E 6) 7	$	R3	2
0 E 1 + 5 T 8	$	R1	2
0 E 1	$	accept	2

+1