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

2. Write a single regular expression for numbers including integers (5, 0, -3, etc.) and floating numbers(7.2, -0.3, etc.). (5p)

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

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

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.)

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

$$\langle A \rangle \rightarrow \langle A \rangle a \mid b$$

$$\langle B \rangle \rightarrow \langle B \rangle b \mid a$$

aababbab	Yes	No
abab	Yes	No
baba	Yes	No
baaaabb	Yes	No

b. Prove that the grammar is ambiguous.

P3 [30 points] Consider the following grammar:

$\langle S \rangle \;\rightarrow\; \langle S \rangle + \langle S \rangle \mid \langle id \rangle$

$\langle id \rangle \;\rightarrow\; a \mid b \mid c$

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

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

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	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		

The Action header spans columns id, +, (,), $. The GoTo header spans columns E, T.

Stack	Input	Action
0	id+(id)$	