University of Nevada, Las Vegas Computer Science 456/656 Spring 2026

Assignment 4: Due Tuesday March 31, 2026, 11:59:59 PM

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. Turn in the assignment as instruced by the Graduate Assistant, Shubhashish Kar, `shubhashish.kar@unlv.nevada.edu`

"When all else fails, follow instructions."

1. State the pumping lemma for regular languages.

2. Use the pumping lemma for regular languages to prove that $L = \{a^n b^n a^n : n \geq 0\}$ is not a regular language.

3. Prove that every decidable language is enumerated in canonical order by some machine.

4. Prove that if L is enumerated in canonical order by some machine, L is decidable.

5. Prove that every language accepted by any machine is recursively enumerable.

6. Prove that every recursively enumerable language is accepted by some machine.

7. Finish the LALR parser for the following grammar, where E is the start symbol, and the language has both subtraction and negation. I have filled in all but one column.

1. $E \to E -_2 E_3$
2. $E \to -_4 E_5$
3. $E \to (_6 E_7)_8$
4. $E \to x_9$

	x	$-$	(	)	\$	E
0	$s9$		$s6$			1
1					halt	
2	$s9$		$s6$			3
3				$r1$	$r1$	
4	$s9$		$s6$			5
5				$r2$	$r2$	
6	$s9$		$s6$			7
7				$s8$		
8				$r3$	$r3$	
9				$r4$	$r4$	

8. Consider the annotated CF grammar and LALR parser. Walk through the computation of the parser for the input string $x + x + x * x * x \wedge x \wedge x$.

   1. $E \to E +_2 E_3$
   2. $E \to E *_4 E_5$
   3. $E \to E \wedge_6 E_7$
   4. $E \to x_8$

	x	$+$	$*$	$\wedge$	\$	E
0	$s8$					1
1		$s2$	$s4$	$s6$	halt	
2	$s8$					3
3		$r1$	$s4$	$s6$	$r1$	
4	$s8$					5
5		$r2$	$r2$	$s6$	$r2$	
6	$s8$					7
7		$r3$	$r3$	$s6$	$r3$	
8		$r4$	$r4$	$r4$	$r4$	