University of Nevada, Las Vegas Computer Science 456/656 Spring 2021
Assignment 5: Due Thursday April 1, 2021

Finished

Name: _____

You are permitted to work in groups, get help from others, read books, and use the internet. Post your answers on Canvas as instructed by the graduate assistant, Mr. Singh, by 11:59 PM on the due date.

Some of the problems are to write proofs. Although you may simply copy a proof from my class presentation or from some other source, it would help if you try to undestand the proof. I will ask for proof(s) on the exam and on the final.

1. Consider G, the following context-free gammar with start symbol E. Stack states are indicated.

   1. $E \rightarrow E_{1,11} +_2 E_3$
   2. $E \rightarrow E_{1,11} -_4 E_5$
   3. $E \rightarrow E_{1,3,5,11} *_6 E_7$
   4. $E \rightarrow -_8 E_9$
   5. $E \rightarrow (_{10} E_{11})_{12}$
   6. $E \rightarrow x_{13}$

   What follows is an ACTION table followed by a GOTO table for an LALR parser for G. Which entry guarantees that negation has higher priority than multiplication?

   I somehow forgot to fill in the column headed by "−." Fill it in. Hint: unlike the others, this column contains no empty cells. Remember that the minus sign is used for both subtraction and negation.

	x	$+$	$-$	$*$	$($	$)$	$\$$	E
0	s13				s10			1
1		s2		s6			**halt**	
2	s13				s10			3
3		r1		s6		r1	r1	
4	s13				s10			5
5		r2		s6		r2	r2	
6	s13				s10			7
7		r3		r3		r3	r3	
8	s13				s10			9
9		r4		r4		r4	r4	
10	s13				s10			11
11		s2		s6		s12		
12		r5		r5		r5	r5	
13		r6		r6		r6	r6	

2. State the pumping lemma for context-free languages.

3. Use the pumping lemma to prove that $L = \left\{ a^j b^k c^\ell \ : \ 0 \leq j \leq k \leq \ell \right\}$ is not context-free.

4. Consider the following problem. Given binary numerals $\langle u \rangle$ and $\langle v \rangle$ of length n, decide whether $u < v$. Give an $\mathcal{NC}$ algorithm for solving this problem.

5. Prove that a language is enumerable in canonical order by some machine if and only if it is decidable.