University of Nevada, Las Vegas Computer Science 456/656 Spring 2023

Review 1

1. True, False, or Open.

   (a) _____ If S is an infinite set, then 2^S must be uncountable.

   (b) All standard arithmetic and matrix operations, as well as square root, are $\mathcal{NC}$.

2. Label each of the following sets as countable or uncountable.

   _____ The set of integers.
   _____ The set of real numbers.
   _____ The set of rational real numbers.
   _____ The set of irrational real numbers.
   _____ The set of binary languages.
   _____ The set of co-RE binary languages.
   _____ The set of decidable binary languages.
   _____ The set of undecidable binary languages.
   _____ The set of unary languages.
   _____ The set of functions from integers to integers.
   _____ The set of recursive real numbers.
   _____ The set of algebraic numbers.

   A number is algebraic if it is a root of a polynomial with integral coefficients.

3. Each language class is closed under which operators? Write "T" or "F" in each cell.

	union	intersection	complement	concatenation	Kleene closure
regular					
$\mathcal{NC}$					
context-free					
$\mathcal{P}$–TIME					
$\mathcal{NP}$					
co-$\mathcal{NP}$					
$\mathcal{P}$–SPACE					
context-sensitive					
recursively enumerable					
co-recursively enumerable					
undecidable					

4. Which of these problems, or languages, are **known** to be $\mathcal{NP}$–complete? (Write T or F)

_____TSP (traveling salesman)
_____partition
_____block sorting
_____equivalence of DFAs
_____equivalence of NFAs
_____equivalence of regular expressions
_____equivalence of regular grammars
_____equivalence of context-free grammars
_____Boolean circuit problem
_____2SAT
_____3SAT
_____4SAT
_____generalized checkers (any size board)
_____vertex cover
_____independent set
_____dominating set
_____integer factoring with binary numerals
_____Rush Hour
_____Hex (the game)
_____Nim (the game)

5. Fill in the ACTION and GOTO tables for the grammar given below, with start symbol E.

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

	x	$+$	$-$	$*$	(	)	\$	E
0								
1							**halt**	
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

6. Give a proof that the set of real numbers is uncountable.