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

Assignment 4: Due Saturday October 24, 2026, midnight

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, Sabrina Wellace, `wallace4@unlv.nevada.edu`

1. True **T**/False **F**/Open **O**, meaning that the answer is not known to science at this time.

   (i) _____ The set of all regular expressions over a given alphabet is a regular language.

   (ii) _____ Every regular language is $\mathcal{NC}$.

   (iii) _____ The CVP (Circuit Value Problem) is $\mathcal{NC}$.

   (iv) _____ Evaluation of a Boolean expression given an assignment is $\mathcal{NC}$.

   (v) _____ $2-SAT$ is $\mathcal{P}$–TIME

   (vi) _____ $4-SAT$ is $\mathcal{P}$–TIME

   (vii) _____ Every context-free language is generated by some Chomsky Normal Form grammar.

   (viii) _____ Every $\mathcal{RE}$ (recursively enumerable) language is generated by some general grammar. Every context-free language is generated by some Chomsky Normal Form grammar.

   (ix) _____ $\mathcal{P} = \mathcal{NC}$

   (x) _____ If L is $\mathcal{P}$–TIME, there is a $\mathcal{NC}$ reduction of L to CVP.

   (xi) _____ Every regular language is $\mathcal{NC}$.

   (xii) _____ Given two regular expressions the problem of whether they are equivalent (that is, descirbe the same regular language) is $\mathcal{P}$-TIME.

2. Each of these languages or, equivalently, 0-1 problems. Mark each them Y (for yes) it it is known to be $\mathcal{NP}$-complete, and N (for no) it is not known to be $\mathcal{NP}$-complete. (You may have to consult the internet.)

   (i) _____ $2-SAT$

   (ii) _____ $3-SAT$

   (iii) _____ $4-SAT$

   (iv) _____ TSP, the Traveling Salesman Problem.

   (v) _____ 2-coloring of a graph.

   (vi) _____ Haniltonian circuit problem. Does a given graph has a Hamiltonian circuit?

   (vii) _____ 3-coloring of a graph.

   (viii) _____ Block sorting. Given a string w can w be sorted within K block steps for a given K?

   (ix) _____ Generalized Checkers. Given a position on an $N \times N$ board, can Black force a win?

   (x) _____ RUSH HOUR. Given a position of the "cars" in a "parking lot" of arbitray size, is there a way to move the red car out?

3. Identify which machine accepts the language defined by each regular expression.

(a) $a^* + b^*$

(b) λ

(c) a^*

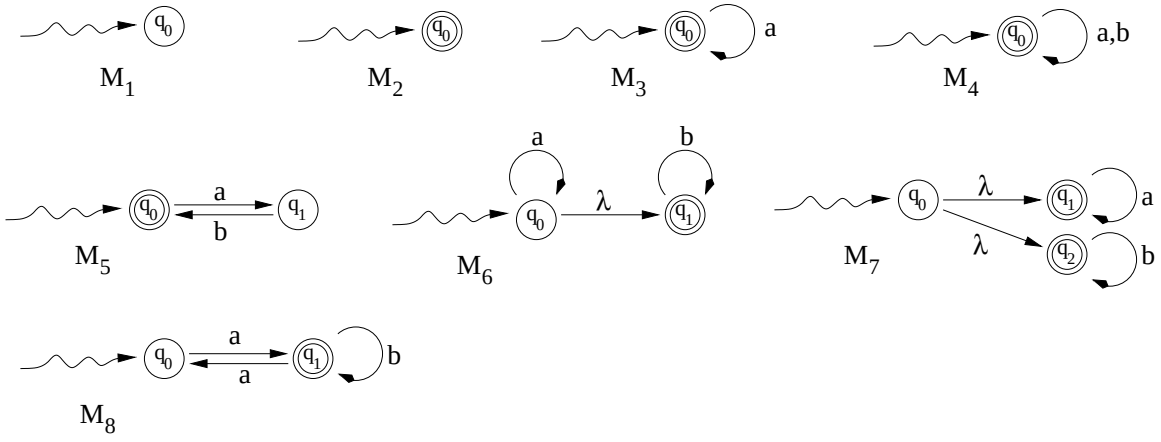
(d) $\emptyset$

(e) $a(aa + b)^*$

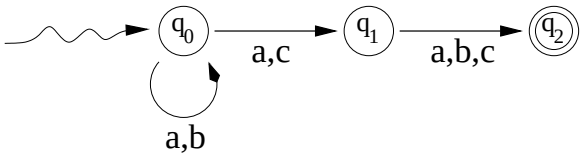
(f) a^*b^*

(g) $(a + b)^*$

(h) $(ab)^*$



4. Write a regular expression for the language accepted by the NFA below.



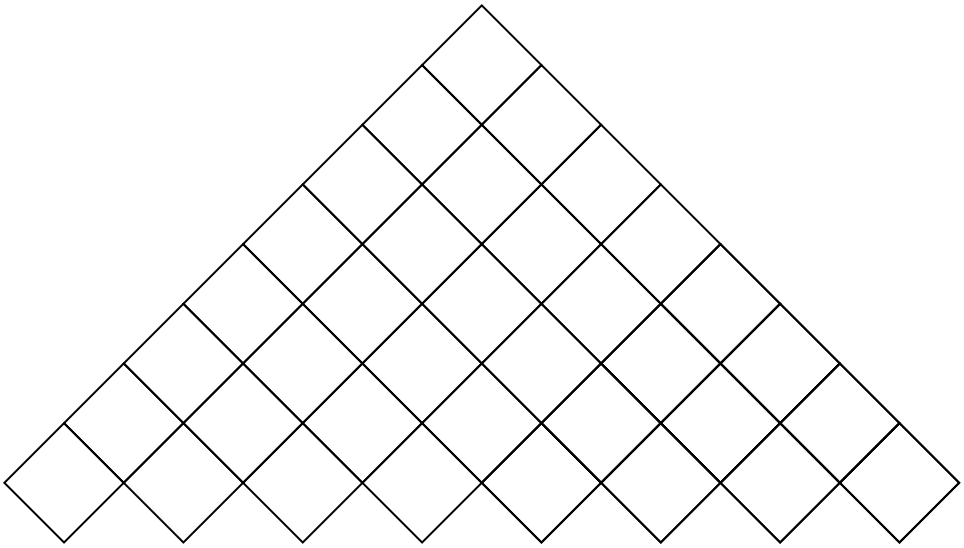
5. Write a Chomsky Normal Form grammar for the Dyck language.

6. Consider the Chomsky Normal Form grammar G given below, where S is the start symbol.

$S \to IS$
$S \to WS$
$S \to XY$
$X \to IS$
$Y \to ES$
$S \to a$
$I \to i$
$W \to w$
$E \to e$

(i) Show that G is ambiguous by giving two different **leftmost** derivations for the string $iiaea$.

(ii) Use the CYK algorithm to prove that $iwiaewa \in L(G)$.



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