

FINAL EXAM

CS372 FORMAL LANGUAGES & THE THEORY OF COMPUTATION

Student ID: _____

Name: _____

Instructions:

You have 90 minutes to complete the exam. Answer Parts A and B.

The exam will be closed book. You are not allowed to use phones and laptops too. However, you are allowed to bring a hard copy of my slides with review notes (without multiple choice questions).

PART 1: YES/NO AND MULTIPLE CHOICE QUESTIONS

YES/NO QUESTIONS

1. The set of compliments of regular languages is co-NP.

2. Language

$$L = \{a^m b^n c^{\max(m,n)} \mid m, n \in \mathbb{N}\}$$

is regular.

3. It is possible that the intersection of a finite number of regular languages is not regular.

4. Language

$$L = \{(ab)^n a^n b^n \mid n > 0\}$$

is context free.

5. Grammar

$$\{S \rightarrow 1S1; S \rightarrow T; T \rightarrow 1X1; T \rightarrow X; X \rightarrow 0X0; X \rightarrow 1\}$$

is ambiguous.

6. For every CFL, G , there exists a DPDA M such that $L(G) = L(M)$ and vice versa.

7. The operations of PDA never work on elements, other than the top of stack.

8. A Turing machine can simulate any algorithmic computation.

- 9.

$$E_{\text{TM}} = \{(M) \mid M \text{ is a TM and } L(M) = \emptyset\}$$

is in NP complete.

10. Ordinary Turing machines (deterministic, 1 tape) and Multitape Turing machines are equivalent in terms of the language they can recognize.

MULTIPLE CHOICE QUESTIONS

11. Which of the following components is not in the formal definition of a Deterministic Pushdown Automaton?

A. Set of states

B. Tape alphabet

- C. Stack alphabet
 - D. Input alphabet
12. Which of the following is true about regular languages?
- A. Language $L = \{w \in \{0, 1\}^* \mid w \text{ has an equal number of 0's and 1's}\}$ is regular.
 - B. All infinite languages have infinite complements.
 - C. Given a DFA D , there is a procedure to find a regular expression to denote $L(D)$.
 - D. If L^* is regular, then L is regular.
13. Turing machine (TM) is more powerful than FMS (Finite State Machine) because
- A. tape movement is confined to one direction.
 - B. it has no finite state
 - C. it has the capability to remember arbitrarily long sequences of input symbols
 - D. none of these
14. TM states are called the halt states:
- A. ACCEPT AND WRITE
 - B. ACCEPT and READ
 - C. ACCEPT AND START
 - D. ACCEPT and REJECT
15. Which of the following is false about the power of
- A. DTM and NTM are the same
 - B. NTM and RE are different
 - C. DPDA and DTM are different
 - D. DPDA and NPDA are the same
16. Let N is an NFA with n states. If we convert N to an equivalent DFA using subset construction. Here we are seeking an approximate bound on the number of states in D . Choose the best answer of the possibilities below
- A. $O(n^2)$
 - B. $O(n \log n)$
 - C. $O(2^n)$
 - D. Larger than any of the above.
17. Consider the language

$$L = \{w\#w^R \mid w \in \{a, b\}^*\}.$$

Suppose we are in the process of attempting to demonstrate that L is not a regular language using the Pumping Lemma for regular languages. Which of the following strings is a suitable choice for the string z in the statement of the lemma (p is the pumping length)?

- A. $aaaa\#aaaa$
- B. $aaaa\#bbbb$
- C. $a^p\#b^p$
- D. $a^p\#a^p$

18. The language which is generated by the grammar

$$S \rightarrow aSa \mid bSb \mid \varepsilon$$

over the alphabet $\{a, b\}$ is the set of

- A. Strings that begin and end with the same symbol
- B. All odd and even length palindromes (sequence that reads the same backward as forward)
- C. All odd length palindromes
- D. All even length palindromes

19. Let

$$A = \left\{ \begin{bmatrix} 001 \\ 01 \end{bmatrix}, \begin{bmatrix} 0011 \\ 111 \end{bmatrix}, \begin{bmatrix} 11 \\ 111 \end{bmatrix}, \begin{bmatrix} 101 \\ 010 \end{bmatrix} \right\}$$

and

$$B = \left\{ \begin{bmatrix} 00 \\ 0 \end{bmatrix}, \begin{bmatrix} 001 \\ 11 \end{bmatrix}, \begin{bmatrix} 1000 \\ 0111 \end{bmatrix} \right\}.$$

are two instances of post-correspondence problem. Which of the following statements is true

- A. Only A has a match
- B. Both A and B have a match
- C. Only B has a match
- D. Neither A nor B has a match

20. To which of the following class does the NPCP problem belong?

- A. P class
- B. co-NP class
- C. NP complete class
- D. None of the above

ANSWER SHEET

QUESTION	ANSWER
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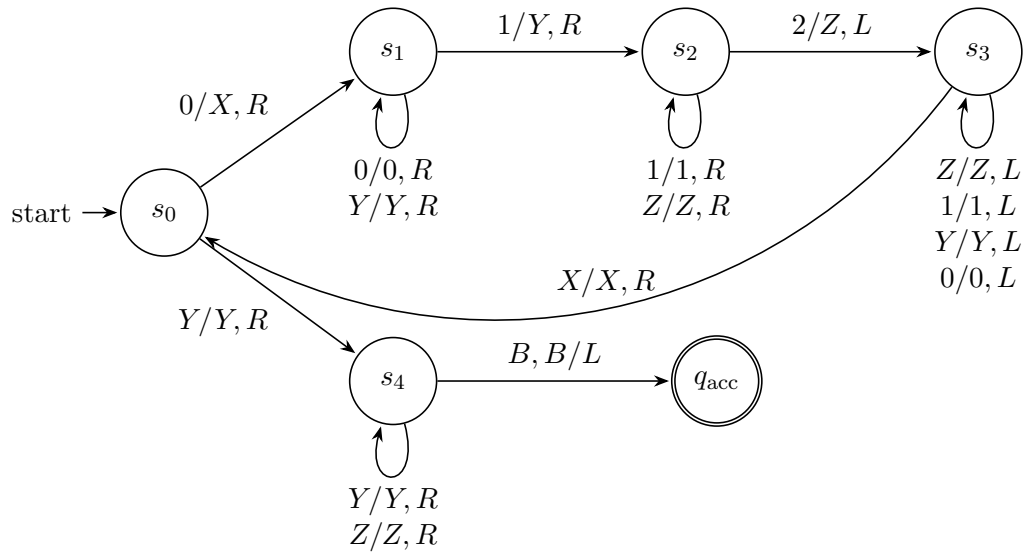
PART II: WRITING EXAM

Question 1. Consider the following grammar:

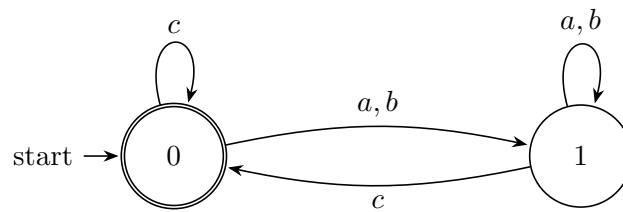
$$G : S \rightarrow 00S \mid S1 \mid 1$$

- (a) Describe the language $L(G)$ using set notation?
- (b) Convert G to an equivalent NPDA

Question 2: Consider the following Turing machine M . Give the sequence of configurations that M enters when started on input string 012.



Question 3: Consider the following deterministic finite automaton D



- (a) Give the encoding of D
- (b) Give a true instance of the problem of acceptance of a regular language with the given automaton.