

CSC 456/656 Fall 2023 First Examination Problems to Study

1. True or False. 5 points each. T = true, F = false, and O = open, meaning that the answer is not known science at this time.

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- (i) _____ Every subset of a regular language is regular.
- (ii) _____ The class of regular languages is closed under intersection.
- (iii) _____ $\mathcal{P}\text{-TIME} = \mathcal{NP}$.
- (iv) _____ The class of regular languages is closed under Kleene closure.
- (v) _____ The class of context-free languages is closed under union.
- (vi) _____ The class of context-free languages is closed under intersection.
- (vii) _____ The set of binary numerals for prime numbers is a regular language.
- (viii) _____ The complement of any $\mathcal{P}\text{-TIME}$ language is $\mathcal{P}\text{-TIME}$.
- (ix) _____ The complement of any context-free language is context-free.
- (x) _____ The complement of any recursive (that is, decidable) language is recursive.
- (xi) _____ If Σ is an alphabet, then Σ^* is a regular language.
- (xii) _____ If L is a language and L^* is a regular language, then L must be a regular language. (**Think!**)
- (xiii) _____ The class of languages which are **not regular** is closed under intersection. (**Think!**)
- (xiv) _____ A minimal DFA equivalent to an NFA with n states must have 2^n states.
- (xv) _____ If a non-deterministic machine can solve a given problem in polynomial time, then there is a deterministic machine which can solve the same problem in polynomial time.
- (xvi) _____ If a non-deterministic machine can solve a given problem in polynomial time, then there is a deterministic machine which can solve the same problem in exponential time.

2. 10 Give an example of a language which is context-free but not regular.

3. 10 Give an example of a language which is not context-free.
4. 20 Let L be the language of all binary strings encoding numbers which are equivalent to 1 modulo 3, where leading zeros are allowed. Thus, $L = \{1, 01, 001, 100, 111, 0100, 0111, 1010, \dots\}$. Draw a DFA which accepts L . (You need only three states.)
5. 20 Let G be the CF grammar given below, where E is the start symbol. Show that G is ambiguous by giving two different **rightmost** derivations for the string $x - y * z$.
1. $E \rightarrow E - E$
 2. $E \rightarrow E * E$
 3. $E \rightarrow x$
 4. $E \rightarrow y$
 5. $E \rightarrow z$
6. 20 Give a grammar for the language accepted by the NFA shown in Figure 1 below.

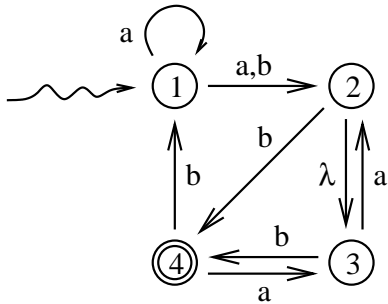


Figure 1: NFA for problems 6 and 9.

7. 20 Give a regular expression for the language accepted by the following NFA

