# CSC 456/656 S26 Study Guide First Examination February 11, 2026

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

   (i) ______ Every subset of a regular language is regular.

   (ii) ______ The set of binary numerals for prime numbers is in $\mathcal{P}$–TIME.

   (iii) ______ Every language is countable.

   (iv) ______ The set of languages over the binary alphabet is countable.

   (v) ______ $\mathcal{P} = \mathcal{NP}$.

   (vi) ______ The complement of any $\mathcal{P}$–TIME language is $\mathcal{P}$–TIME.

   (vii) ______ The complement of any $\mathcal{NP}$ language is $\mathcal{NP}$.

   (viii) ______ The complement of any decidable language is decidable.

   (ix) ______ If $L$ is both $\mathcal{NP}$ and co–$\mathcal{NP}$, then $L$ must be $\mathcal{P}$–TIME.

   (x) ______ If $L$ is both $\mathcal{RE}$ and co–$\mathcal{RE}$, then $L$ must be decidable.

   (xi) ______ Every context-free language is $\mathcal{P}$–TIME.

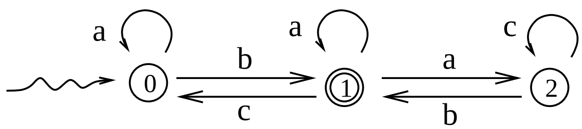
   (xii) ______ The halting problem is $\mathcal{RE}$.

   (xiii) ______ The CFG equivalence problem is $\mathcal{RE}$.

   (xiv) ______ The language accepted by a DFA $M$ contains the empty string if and only if the start symbol of $M$ is final.

2. Let $L$ be the language of all binary strings which do not contain the substring 010. Draw a DFA which accepts $L$.

3. Construct a minimal DFA equivalent to $M$ the NFA shown below.




4. Give a regular expression for the language accepted by the NFA shown in problem 3.

5. Give a language which is not regular.

6. Let $L$ be the set of binary numerals for positive integers which are equivalent to 1 modulo 3. ($\langle n \rangle$ such that $n\%3 = 1$) That is, $L = \{1, 100, 111, 1010, 1101, \ldots\}$. Draw a DFA that accepts $L$.

7. Draw a minimal DFA which accepts each of the following languages.

   (i) The language $\{a\}$.

   (ii) The language $\{\lambda\}$.

   (iii) The empty language.

   Draw the state diagram for a DFA which accepts the language generated by the following regular grammar. Hint: the DFA must have at least 3 states.

   1. $S \to aS$
   2. $S \to bA$
   4. $A \to a$
   5. $A \to bS$

9. If someone proved that every binary numeral could be factored into primes in polynomial time, what would be the practical consequence?

10. State the *certificate/verification* definition of the class $\mathcal{NP}$.