Theory of Computation - Assignment 2 - Due: 14-Mar-2025, 5 PM

1. Pumping Lemma is used to check
   (a) whether a language is non-regular
   (b) whether a language is regular
   (c) can check both regularity and non-regularity
   (d) can check whether a language has a DFA or not
2. Which of the following languages are non-regular
   (a) $L = \{a^{2n}\}$
   (b) $L = \{a^{n^2}\}$
   (c) $L = \{a^{2n+5m}\}$
   (d) $L = \{a^{Fibonacci(n)}\}$
3. Which of the following languages are regular
   (a) $L = \{1^n \mid nmod5 = 0\}$
   (b) $L = \{1^n 0^m \mid gcd(m, n) = 1\}$
   (c) $L = \{x \mid x \in \{a, b\}^*, \text{the number of a's is just one more than the number of b's}\}$
   (d) All strings over $\{a, b\}^*$ of length 100.
4. Consider the following CFG
   $S \to aB \qquad S \to bA$
   $B \to b \qquad A \to a$
   $B \to bS \qquad A \to aS$
   $B \to aBB \qquad A \to bAA$
   Consider the following derivation
   $S \Rightarrow aB$
   $\Rightarrow aaBB$
   $\Rightarrow aaBb$
   $\Rightarrow aabSb$
   $\Rightarrow aabbAb$
   $\Rightarrow aabbab$

   This derivation is
   (a) a leftmost derivation
   (b) a rightmost derivation
   (c) both leftmost and rightmost derivation
   (d) neither leftmost nor rightmost derivation
5. Consider the following language
   $L = \{a^n b^n / n \geq 1\}$
   L is
   (a) CFL but not regular
   (b) CSL but not CFL

(c) regular

(d) type 0 language but not type 1

6. Which of the following is true for an arbitrary language L.

(a) $L^* = \bigcup_{i=1}^{\infty} L^i$

(b) $L^* = L^+ \cup \{\lambda\}$

(c) $L^* = L^+$

(d) $L^* = L^+ - \{\lambda\}$

7. Which of the following denotes Chomskian hiearchy?

(a) $REG \subset CFL \subset CSL \subset type0$

(b) $CFL \subset REG \subset type0 \subset CSL$

(c) $CSL \subset type0 \subset REG \subset CFL$

(d) $CSL \subset CFL \subset REG \subset type0$

8. Which of the following regular expressions denotes a language comprising of all possible strings over $\Sigma = \{a, b\}$ of length n where n is a multiple of 3.

(a) $(a + b + aa + bb + aba + bba)^*$

(b) $(aaa + bbb)^*$

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

(d) $(aaa + ab + a) + (bbb + bb + a)$

9. Which of the following statement is wrong?

(a) Any regular language can be generated by a context-free grammar

(b) Some non-regular languages cannot be generated by any CFG

(c) the intersection of a CFL and regular set is a CFL

(d) All non-regular languages can be generated by CFGs.

10. R_1 and R_2 are regular sets. Which of the following is not true?

(a) $R_1 \cap R_2$ neet not be regular

(b) $\Sigma^* - R_1$ is regular

(c) $R_1 \cup R_2$ is regular

(d) R_1^* is regular

11. Which of the following regular expression identity is true?

(a) $r(*) = r^*$

(b) $(r^*s^*)^* = (r + s)^*$

(c) $(r + s)^* = r^* + s^*$

(d) $r^*s^* = r^* + s^*$

12. Which one of the following statement is FALSE?

(a) context-free languages are closed under union

(b) context-free languages are closed under concatenation

(c) context-free languages are closed under intersection

(d) context-free languages are closed under Kleene closure

13. Which of the following conversion is not possible (algorithmically)?

(a) regular grammar to context-free grammar

(b) nondeterministic FSA to deterministic FSA

(c) nondeterministic PDA to deterministic PDA

(d) nondeterministic TM to deterministic TM

14. Which of the following statements is TRUE?

(a) infinite union of regular sets is regular

(b) infinite union of finite sets is regular

(c) finite union of finite sets is regular

(d) complement of a finite set need not be regular

15. Consider the languages
$L_1 = \{ww^R / w \in \{0,1\}^*\}$
$L_2 = \{wcw^R / w \in \{0,1\}^*\}$
$L_3 = \{ww / w \in \{0,1\}^*\}$
Which one of the following is TRUE?

(a) L_1 is deterministic CFL

(b) L_2 is deterministic CFL

(c) L_3 is a CFL but not a deterministic CFL

(d) L_3 is deterministic CFL

16. $L_1 = \{a^{n+m}b^nc^m / n, m \geq 0\}$
$L_2 = \{a^{n+m}b^{n+m}c^m / n, m \geq 0\}$
$L_3 = \{a^{n+m}b^{n+m}c^{n+m} / n, m \geq 0\}$
Which of these languages are not CF.

(a) L_1 only

(b) L_3 only

(c) L_1 and L_2

(d) L_2 and L_3

17. If s is a string over $(0+1)^*$ then let $m_0(s)$ denote the number of 0's in s and $n_1(s)$ the number of 1's in s. Which one of the following languages is not regular?

(a) $L = \{s \in (0+1)^* / n_0(s)$ is a 3-digit prime$\}$

(b) $L = \{s \in (0+1)^* /$ for every prefix s' of s, $|n_0(s') - n_1(s')| \leq 2\}$

(c) $L = \{s \in (0+1)^* / |n_0(s) - n_1(s)| \leq 4\}$

(d) $L = \{s \in (0+1)^* / n_0(s)\ mod\ 7 = n_1(s)\ mod\ 5 = 0\}$

18. For $s \in (0+1)^*$ let $d(s)$ denote the decimal value of s (eg. $d(|0|) = 5$). Let $L = \{s \in (0+1)^* | d(s)\ mod\ 5 = 2$ and $d(s)\ mod\ 7 \neq 4\}$
Which one of the following statements is TRUE?

(a) L is recursively enumerable but not recursive

(b) L is recursive, but not context-free

(c) L is context-free, but not regular

(d) L is regular