

## CSE331 Section 07 & 08 Assignment 2

Spring 2025

Total Marks: 40

Due: 08/05/2025, 11:59 PM

*Your solutions need to be handwritten. After writing down your solutions, scan and compile your answers into a single pdf file. Then submit in the following Google Form:*

<https://forms.gle/gm6KEaoetcSapHfT9>

### Question 1

[10 Points]

Use the Pumping Lemma to demonstrate that the following languages are not regular.

- a)  $L1 = \{w \in \{0, 1\}^*: 0^i 1^j \text{ where } i \leq j\}$
- b)  $L2 = \{w \in \{a, b, c\}^*: a^i b^j c^{k+2} \text{ where } i = k \text{ and } i, j, k \geq 0\}$
- c)  $L3 = \{w1\#w2 \text{ such that } |w1| = 2 \cdot |w2|, \text{ where } w1, w2 \in \{0, 1\}^*\}$
- d)  $L4 = \{w \in \{a\}^*: a^{2^n} \text{ where } n \geq 0\}$

### Question 2

[20 Points]

Give a context-free grammar for each of the following languages.

Consider,  $\Sigma = \{0, 1\}$ .

- A. The language of strings that start with 1
- B. The language of strings of the form  $ww^R$
- C. The language of strings that contain the substring 001
- D. The language  $\{0^n 10^n \text{ where } n \geq 0\}$
- E. The language  $\{0^i 1^j \text{ where } i \leq j\}$
- F. The language  $\{1^i 01^j 01^{i+j}\}$
- G. The language  $\{0^{3n} w 1^{2n} \text{ where } n \geq 0 \text{ and } w \text{ is a string that contains at least two } 0\text{'s}\}$
- H. The language  $\{0^i 10^j \mid i \text{ is a multiple of three where } i, j \geq 0\}$
- I. The language  $\{0^i 10^j \mid j = 2 + 3i \text{ where } i, j \geq 0\}$
- J. The language  $\{1^i 01^j \mid j \text{ is a multiple of four or } i = 3 + 2j \text{ where } i, j \geq 0\}$

### Question 3

[10 Points]

1. Suppose, you are given the following grammar.  $\Sigma = \{0, 1\}$

$S \rightarrow SS \mid 0S1 \mid 1S0 \mid 01 \mid 10$

- a) Show that the grammar is ambiguous by demonstrating two different parse trees. [Hint: String 011010]
- b) Find two strings of length six in the grammar above where exactly one parse tree is possible.

2. Suppose, you are given the following grammar.  $\Sigma=\{a,b\}$

$S \rightarrow PE$

$P \rightarrow aPa \mid bPb \mid a \mid b$

$E \rightarrow aaE \mid abE \mid baE \mid bbE \mid \varepsilon$

- a) Give a leftmost derivation for the string abababb and sketch the parse tree corresponding to that derivation.
- b) Demonstrate that the given grammar is ambiguous by showing two more parse trees (apart from the one you already found in (a)) for the same string abababb.