

Indian Institute of Engineering Science and Technology, Shibpur

B. Tech. (CST) 4th Semester Mid-Term Examination, April 2021

Theory of Computation (CS2204)

Full Marks: 30

Time: 45 Minutes

- Attempt Question No. 1 and any 2 from the remaining 3.
- The number within square brackets ([]) at the end of each question indicates its marks.
- Answers should be precise and to the point.
- Make your own assumptions, if necessary, and state them at proper places.

1. State whether the statement is true or false (1 mark)! Formally justify your answer (remaining marks)!

(a) Any finite language L over an alphabet Σ can itself be the alphabet for some other language \mathcal{L} . [1 + 2]

(b) A grammar $G = (V, \Sigma, R, S)$ is Regular if and only if it is Context-Free. [1 + 2]

(c) Both ϕ and $\{e\}$ are regular languages over the alphabet $\{a, b\}$. [1 + 3]

2. As stated at its side, for **each** of the following languages construct a Pushdown Automaton (PDA) that accepts **OR** a Context-Free Grammar (CFG) that generates the language.

(a) $\{a^m b^n c^l \mid l, m, n \geq 0 \text{ and } m \leq l + n\}$ [CFG] [3]

(b) $\{a^m b^n \mid m, n \geq 0 \text{ and } m \neq n\}$ [PDA] [4]

(c) $\{\omega \in \{a, b\}^* \mid \omega \text{ has more } a\text{'s than } b\text{'s}\}$ [CFG] [3]

3. For **each** of the following languages, show that it is not regular.

(a) $\{\omega\omega^R \mid \omega \in \{a, b\}^*, \text{ where } \omega^R \text{ is reverse of } \omega.\}$ [5]

(b) $\{\omega \in \{a, b\}^* \mid \omega \text{ has same number of } a\text{'s and } b\text{'s (in any order).}\}$ [5]

4. For **each** of the following languages construct a Deterministic Finite Automaton (DFA) that accepts the language.

(a) The language $L \subseteq \{a, b\}^*$ represented by the regular expression $(aab)^*(bba)^*$ [5]

(b) $\{\omega \in \{a, b, c\}^* \mid \omega \text{ contains either } abcba \text{ or } bacab \text{ as its substrings, but not both.}\}$ [5]