Indian Institute of Engineering Science and Technology, Shibpur

B. Tech. (CST) 4^{4tg} Semester Mid-Term Examination, March 10, 2022

Theory of Computation (CS 2204)

Full Marks: 30 Time: 45 Min

- Attempt all questions.
- Answers should be precise, to the point, and in your own words as far as practicable.
- Make your own assumptions, if necessary, and state them at proper places.
- 1. For each of the following languages construct an **Automaton** (DFA or NDFA or PDA as stated at the end of each language) that accepts the language.
 - (a) $\{\omega \in \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}^* \mid \omega \text{ is an integer in decimal notation, which is$ **not divisible** $by 5 and <math>\omega$ should not start with a 0.} For example, 6, 12, 33, etc. are valid strings of the language, whereas, 06, 45, etc. are not. [Construct a DFA.]
 - (b) $\{\omega \in \{a,b\}^* \mid \text{The number of '}a\text{'s in }\omega \text{ is not more than twice the number of '}b\text{'s in it.}\}\$ [Construct a PDA]
 - (c) $\{a^m b^n | m, n \ge 0 \text{ and } m \ne n\}$ [Construct a PDA.] [3+4+5]
- 2. For each of the following languages construct a **Grammar** (Regular or Context-Free as stated at the end of each language) that generaes the language.
 - (a) $\{\omega \in \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}^* \mid \omega \text{ is an integer in decimal notation, which is divisible by 3 and } \omega \text{ should not start with a 0.}$ For example, 3, 12, 33, etc. are valid strings of the language, whereas, 03, 44, etc. are not. [Construct a Regular Grammar.]
 - (b) $\{\omega \in \{[,], \{,\}, (,)\}^* \mid \text{ In } \omega \text{ all the brackets are properly matched. For example, } \{[]\} \text{ is not a valid string of the language, whereas, } [\{()\}]() \text{ is one.} \}$ [Construct a Context-Free Grammar.]
 - (c) $\{c\omega_1 c\omega_2 c \dots c\omega_n cc\omega_j^R c \mid 1 \le n, \ 1 \le j \le n, \ \omega_{i,1 \le i \le n} \in \{a,b\}^*, \text{ and } \omega_j^R \text{ stands for reverse of the string } \omega_j \}$ [Construct a Context-Free Grammar.] [3+4+5]
- 3. Given the Regular Expression $r = a(ba)^*b$, systematically construct an NDFA M_1 that accepts the corresponding language L(r) and then, from M_1 , systematically construct a DFA M_2 that accepts the same language.