SPRING END SEMESTER EXAMINATION-2023

4th Semester B.Tech

AUTOMATA AND FORMAL LANGUAGES

CS 2010

(For 2022 (L.E), 2021 & Previous Admitted Batches)

Time: 3 Hours Full Marks: 50

Answer any SIX questions.
Question paper consists of four SECTIONS i.e. A, B, C and D.
Section A is compulsory.
Attempt minimum one question each from Sections B, C, D.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

SECTION-A

1. Answer the following questions. [1 × 10]

(a) Design a Context Free Grammar for the language $L=\{a^n b^{2n} : n \geq 1\}$

(b) Check whether the following grammar is ambiguous or not:
$S \rightarrow a|abSb|aAb$
$A \rightarrow bS|aAAb$
$B \rightarrow b|\lambda$

(c) Design a Context Free Grammar for the following language:
$L = \{w : w \in \{0, 1\}^*$ and w is a palindrome string$\}$

(d) Distinguish between CNF and GNF.

(e) All linear grammars are not regular grammar but all regular grammars are linear. True or False, Justify.

(f) State the Pumping Lemma for Regular Languages.

(g) Design a finite automata for the following language: $L = \{w : w \in \{a, b\}^*$ and length of w is a multiple of four$\}$

(h) Find a regular expression for the following language: $L = \{a^p b^q : p + q$ is even$\}$

(i) Star closure of every regular language is infinite. State True or False with justification.

(j) What is Chomsky's Language Hierarchy?

SECTION-B

2. (a) Design a NFA for the following language and also find a regular expression for the same language: $L = \{w : w \in \{a, b\}^*$ and either w starts with "ab" or ends with "ab"$\}$ [4]

(b) Design Context Free Grammars for the following languages: [2+2]

i) $L=\{0^p 1^q 2^r$: where p, q, r >=0 and $q = p + r\}$

ii) $L= \{0^i 1^j$: i<= j + 4$\}$

3. (a) Design a DFA or NFA for the following languages: [4]

i) $L=L ((aa+bb+ab+ba)^* bb^* aa^* (bb+aa)^*)$

ii) $L=L(ab^*a^*a+ba^*b^*b) \cup L((a+b)^* baba)$

(b) Convert the following grammar into Greibach Normal Form: [4]

$S \rightarrow AB|aB$
$A \rightarrow aab|\ \lambda$
$B \rightarrow bbA|a$

SECTION-C

4. (a) Considering the set of strings on symbol {a, b}, construct a DFA for all string containing "aa" but not "aaa". Then find out its corresponding regular expression. [2+2]

(b) Design an NFA which will accept all string generated by the symbols present in your roll number. Convert the NFA into its corresponding DFA. [4]

5. (a) Consider a language, L= {ww : w∈ {a, b}*}. Show that L is not a Context Free Language, using Pumping Lemma. [4]

(b) Find a left-linear and a right-linear grammar for the language [4]
$L = \{a^p b^q \mid p >= 2 \text{ and } q >= 3\}$.

6. (a) Convert the following Context Free Grammar to Chomsky Normal Form. [5]
$S \rightarrow AABC$
$A \rightarrow aAb \mid \lambda$
$B \rightarrow aB \mid a$
$C \rightarrow aBa \mid bCb \mid \lambda$

(b) Prove that Context Free Languages are closed under Concatenation operation. [3]

SECTION-D

7. (a) Construct a PDA or NPDA for the following language: [4]
$L=\{a^i b^j c^k$: where i = j or i = k $\}$

(b) Construct a NPDA for the given CFG, G = ({S, M, N}, {0,1}, S, P) where the production rules P are given below: [4]
$S \rightarrow MN1 \mid 0$
$M \rightarrow 00M \mid N$
$N \rightarrow 1M1$

8. (a) Design a Turing machine for the following language: [5]
$L = \{ c^{m+n} a^m b^n$: n, m $\geq 1 \}$

(b) Write the Instantaneous Descriptions (IDs) for the input string "cccaab" to the above designed TM. [3]

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