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**Question Paper Code : 30123**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Computer Science and Engineering

CS 3452 — THEORY OF COMPUTATION

(Common to Information Technology)

(Regulations 2021)

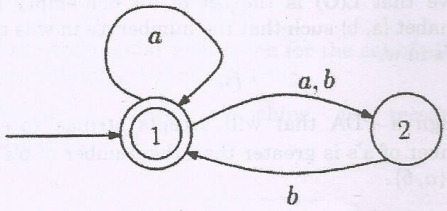
Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate NFA and DFA.

2. Convert the given NFA to an DFA.




3. Prove that reversal of any regular language is also regular.

4. Write a regular expression that recognizes the set of all strings $(0+1)^*$ that do not contain the substrings 00 and 11 over the alphabet $\Sigma = \{0, 1\}$.

5. State the Pumping Lemma for Context Free Languages.

6. What is a Deterministic Push Down Automata?

7. Give the instantaneous description of a TM.

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8. What do you mean by useless symbol? Explain with an example.

9. When is a language L recursively enumerable?

10. What are tractable problems?

PART B — (5 × 13 = 65 marks)

11. (a) Construct NFA accepting the set of strings $\Sigma = \{0, 1\}$ such that two 0's are separated by a string whose length is 4i, for some i>=0. (13)

Or

(b) Prove that for every L recognized by an NFA, there exists an equivalent DFA accepting the same language L. (13)

12. (a) Prove that regular expressions are closed under union, concatenation, Kleene closure, complement. (13)

Or

(b) Prove that any language accepted by a DFA can be represented by a regular expression and also construct a finite automata for the regular expression 10+(0+11)0*1. (13)

13. (a) Let G = (V, E, R, S) be the CFG, where V = {A, B, S}, E = {a, b}, S is the start variable and R consists of the rules

$S \rightarrow aB \mid bA$

$A \rightarrow a \mid aS \mid BAA$

$B \rightarrow b \mid bS \mid ABB$

(i) Prove that ababba $\in$ L(G) (7)

(ii) Prove that L(G) is the set of all non-empty strings w over the alphabet {a, b} such that the number a's in w is equal to the number of b's in w. (6)

Or

(b) (i) Design a PDA that will accepts strings $(a+b)^*$ in which the number of a's is greater than the number of b's given the alphabet $\Sigma = \{a, b\}$. (7)

(ii) Convert the above PDA to its equivalent CFG. (6)

14. (a) (i) Convert the following grammar to CNF (7)

$S \rightarrow ASB \mid \varepsilon$

$A \rightarrow aAS \mid a$

$B \rightarrow SbS \mid A \mid bb$

(ii) Design a Turing machine to compute proper subtraction. (6)

Or



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(b) (i) Convert the following grammar to GNF (7)

$A_1 \rightarrow A_3A_2 \mid A_2A_3$

$A_2 \rightarrow A_3A_3 \mid A_2A_2 \mid a$

$A_3 \rightarrow A_2A_2 \mid b$

(ii) Design a Turing machine that takes a binary number as input and increments the number by 1. (6)

15. (a) (i) Prove that Post Correspondence Problem is undecidable. (7)

(ii) Write short notes on P and NP completeness. (6)

Or

(b) (i) Explain about Universal Turing Machine. (7)

(ii) Discuss Travelling Salesman Problem in terms of P and NP completeness. (6)

PART C — (1 × 15 = 15 marks)

16. (a) Consider the NFA $N = (Q, \Sigma, \delta, q, F)$, where $Q = \{1, 2, 3\}$, $\Sigma = \{a, b\}$, $q = 1$, $F = \{2\}$, and $\delta$ is given by the following table :

| | a | b | c |
|---|---|---|---|
| 1 | {3} | $\phi$ | {2} |
| 2 | {1} | $\phi$ | $\phi$ |
| 3 | {2} | {2, 3} | $\phi$ |

Convert the NFA (N) into DFA (M) that accepts the same language. (15)

Or

(b) (i) Write the regular expression for the set of all strings of 0's and 1's not containing 101 as substring. (5)

(ii) Design a Turing machine to recognize the language $\{0^n1^n0^n \mid n >= 0\}$. (10)

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