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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 : Computer Science and Engineering (Artificial Intelligence and Machine Learning)/
Computer Science and Engineering (Cyber Security)/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. [Figure: NFA with states 1 and 2; state 1 is the start state and the final state; 1 -a-> 1, 1 -a,b-> 2, 2 -b-> 1]
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.
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 $i \geq 0$.

Or

- (b) Prove that for every L recognized by an NFA, there exists an equivalent DFA accepting the same language L.
12. (a) Prove that regular expressions are closed under union, concatenation, Kleene closure, complement.

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. (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 $S \rightarrow ASB \mid \epsilon$, $A \rightarrow aAS \mid a$, $B \rightarrow SbS \mid A \mid bb$ (7)
- (ii) Design a Turing machine to compute proper subtraction. (6)

Or

- (b) (i) Convert the following grammar to GNF $A1 \rightarrow A3A2 \mid A2A3$, $A2 \rightarrow A3A3 \mid A2A2 \mid a$, $A3 \rightarrow A2A2 \mid b$ (7)
- (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 δ is given by the following table: [Table: state - 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.

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 $\{0^n 1^n 0^n \mid n \geq 0\}$. (10)