TDC (CBCS) Odd Semester Exam., 2023

COMPUTER SCIENCE

(Honours)

(5th Semester)

Course No. : CSCHCC-501T

(Theory of Computation)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer *ten* questions, selecting any *two* from each Unit : 2×10=20

UNIT—I

1. Write the complement operation on languages in TOC.

2. Explain the difference between the operations L^+ and L^* in the context of formal languages.

3. Given an alphabet $\Sigma = \{x, y\}$. Find $(\Sigma \cdot \Sigma)^*$, where $\Sigma \cdot \Sigma$ represents concatenation.

UNIT—II

4. Explain the term 'finite automata'.

5. Explain the main characteristics that distinguish a deterministic finite automata from a non-deterministic one.

6. What is transition table in finite automata?

UNIT—III

7. Explain the term leftmost derivation tree.

8. Explain the difference between a non-terminal symbol and a terminal symbol.

9. Consider the context-free grammar

$$G : S \rightarrow aSb|\varepsilon$$

What is the language generated by this grammar?

UNIT—IV

10. Give the formal definition of PDA.

11. Explain the role of a stack in a pushdown automata.

12. Explain the concept of 'closed under homomorphism for context-free language'.

UNIT—V

13. Why do we need Turing machines?

14. Write two properties of recursive enumerable language.

15. What is the significance of a universal Turing machine in the theory of computation?

SECTION—B

Answer *five* questions, selecting *one* from each Unit : 10×5=50

UNIT—I

16. *(a)* Write the applications of theory of computation. 5

(b) Explain the union and intersection on languages. Given two languages $L1 = \{a, b\}$, $L2 = \{b, c\}$. Determine $L1 \cup L2$ and $L1 \cap L2$. 5

17. *(a)* Define the concatenation operation for languages. If $L1 = \{a, aa, aaa\}$ and $L2 = \{b, bb\}$, then find the result of the concatenation $L1 \cdot L2$ and $L2 \cdot L1$. 5

(b) Explain the following terms : 1×5=5

(i) Symbol

(ii) Alphabet

(iii) String

(iv) Power of an alphabet

(v) Finite string

UNIT—II

18. *(a)* Given the alphabet $\Sigma = \{a, b\}$. Construct a transition graph for a finite automata that recognizes the language $L = \{W | W$ contains an even number of 'a' s$\}$. 5

(b) Use the pumping lemma for regular languages to prove that the language

$$L = \{0\text{^}n1\text{^}n | n \geq 0\}$$

is not a regular language. 5

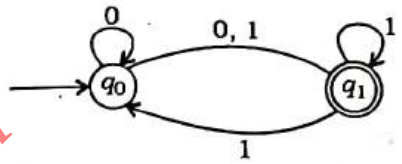
19. *(a)* Design DFA for the following languages : 2+2=4

(i) $L = \{(ab)^n : n \geq 0\}$ over $\Sigma = \{a, b\}$

(ii) $L = \{W \in \{a, b\} : W$ starts with a and ends with $b\}$

(b) What is automata? In the process of NFA to DFA conversion, what is the role of ε-closure? Explain with an example. 3

(c) Convert the given NFA to DFA : 3



UNIT—III

20. *(a)* Give the formal definition of CFG. Also design CFG for the language

$$L = \{a^n b^n : n \geq 0\}$$ 2+3=5

(b) Explain the concept of a parse tree. Consider the context-free grammar

$$G : E \rightarrow E + E \mid E * E \mid (E) \mid id$$

Construct a parse tree for the expression $id + id * id$. 5

21. *(a)* Design a context-free grammar (CFG) that generates the language

$$L = \{a^m b^n c^m \mid m, n \geq 0\}$$

Provide the production rules, start symbol and a step-by-step derivation for the string "*aabccc*" using your CFG. 5

(b) What is unambiguous grammar in TOC? Check whether the given input string *aabb* is ambiguous or not : 5

$S \rightarrow aSb \mid SS$

$S \rightarrow e$

UNIT—IV

22. (a) Define Chomsky normal form and Greibach normal form for context-free grammars. Explain the benefits of these normal forms in terms of simplifying grammar structures and passing. 5

(b) Construct PDA for— 5

(i) $L = \{a^n b^{2n+1}\}$

(ii) $L = \{a^n b^{2n} \mid n \geq 1\}$

23. (a) Use the pumping lemma to prove that the language $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context-free. 5

(b) Design PDA for 5

$L = \{0^n 1^m 2^{(n+m)} \mid m, n \geq 1\}$

UNIT—V

24. (a) Differentiate between recursively enumerable and recursive language. Give examples. 4

(b) Construct a Turing machine which accepts the language *aba* over $\Sigma = \{a, b\}$. 6

25. (a) What are undecidable problems in TOC? Explain. 4

(b) Discuss the notion of language acceptability and decidability in the context of Turing machines. Provide examples to illustrate each concept. 6

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