2025

COMPUTER SCIENCE — HONOURS

Paper : DSCC-11

(Theory of Computation)

Full Marks : 75

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer ***any five*** questions : 2×5

(a) When is a string w said to be accepted by a finite automation?

(b) Give the symbolic definition of a non-deterministic finite automata.

(c) When are two states q_1 and q_2 said to be k-equivalent in a finite automata?

(d) Briefly state the Chomsky classification of grammar.

(e) Describe the set L = set of all strings starting with *a* and ending with *bb*, where $\Sigma = \{a, b\}$ by a regular expression.

(f) Draw the derivation tree for a string w = *aabaa* and context free grammar (CFG) for the grammar given below :

Let G = ({S, A}, {a, b}, P, S), where P consists of $S \rightarrow aAS \mid a \mid SS$, $A \rightarrow SbA \mid ba$.

(g) State the Arden's Theorem on Regular Expression.

(h) Briefly state the useless production in context free Grammar with suitable example.

Section - A

Answer ***any three*** questions.

2. (a) Briefly explain the state minimization algorithm for a DFA. Illustrate the process by means of a non-trivial example.

(b) Classify Mealy and Moore machines with respect to the output functions. 4+1

3. (a) When is an expression in Automata said to be a regular expression?

(b) Write a R.E. for each of the following languages :

(i) The set of all brinary strings where there are no two consecutive 1's.

(ii) The set of all brinary strings where every 1 is immediately followed by three or more 0's.

(iii) The set of all brinary strings whose lengths are multiple of three. 2+3

4. (a) Let L be the set of all palindromes over {p, q}. Construct a grammar G generating L.

(b) Construct a DFA accepting all strings w over {0, 1} such that the number of 1's is w is 2 mod 5. 3+2

5. (a) Define a phase-structure grammar.

(b) If G = ({s}, {0, 1}, {s → 0s1, s → λ}, s), find L(G). 1+4

6. (a) When is a production said to be a null production in a context-free language? Why is it used? Illustrate with a suitable example.

(b) If G is a grammar S → SbS | a, show that G is ambiguous. Assume a suitable string. 2+3

Section - B

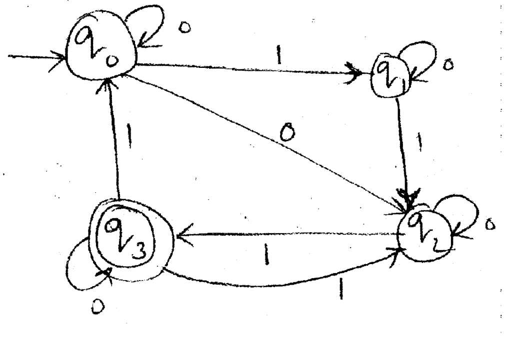
Answer ***any five*** questions.

7. (a) Construct the minimum state automata equivalent to the finite automation represented by the following transition table :

State/Σ	a	b
→ q_0	q_1	q_0
q_1	q_0	q_2
q_2	q_3	q_1
(q_3)	q_3	q_0
q_4	q_3	q_5
q_5	q_6	q_4
q_6	q_5	q_6
q_7	q_6	q_3

(b) Design a DFA that will accept strings which ends with *aba* over $\Sigma = \{a, b\}$. 7+3

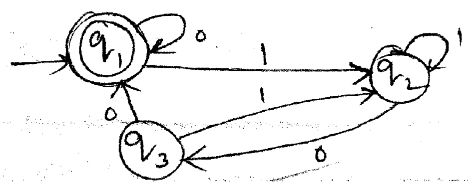
8. (a) Construct a DFA equivalent to the following NDFA :



(b) Construct context-free grammar to generate the language $L = \{a^l\, b^m\, c^n \mid l + m = n\}$. 5+5

9. (a) Discuss briefly about the importance of Chomsky Normal Form.

(b) Construct a regular expression using Arden's theorem for the following state diagram.



5+5

10. (a) Using Pumping lemma, show that the set $L = \left\{a^{i^2} \middle| i \geq 1\right\}$ is not regular.

(b) Design a PDA to recognize all strings consisting equal number of a's and b's. 5+5

11. (a) Define PDA. Define acceptance of input strings by PDA in terms of final states and null store.

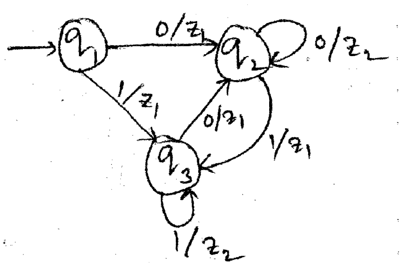
(b) Define Turing machine. Design a Turing machine to recognize all strings consisting of an odd number of 1's. (2+3)+(2+3)

12. (a) Construct a regular grammar accepting $L = \{w \in \{a, b\}^*$ w is a string over $\{a, b\}$ such that the number of b's is 3 mod 4$\}$.

(b) Prove that context-free language is closed under union and concatenation. 4+(3+3)

13. (a) Show that if L_1 is regular and L_2 is regular then, $L_1 \cap L_2$ is also regular.

(b) Consider a Mealy machine given below. Construct a Moore machine equivalent to this Mealy machine.



4+6

14. (a) Construct the regular grammar to generate the language $L = \{a^l b^m c^n \mid l, m, n \geq 1\}$.

(b) Prove that regular language is closed under complementation and kleene closure. 4+(3+3)