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Question Paper Code : 11175

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Fourth Semester

Computer Science and Engineering

CS3452 — 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

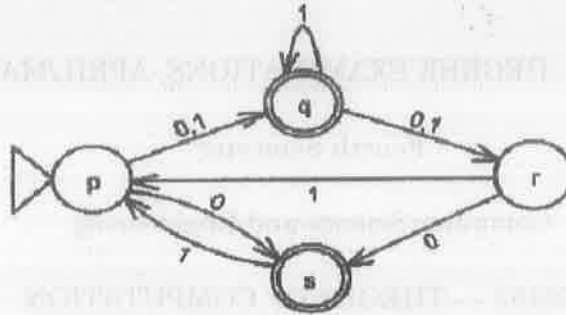
Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How is the transition function in a DFA differ from that of an NFA?
2. What are the distinguishable states? How do they identify?
3. Write a regular expression for all strings over {0, 1} that contain the substring 01.
4. What is the image of the string 1001 under the homomorphism $h(0) = b$ $h(1) = ac$?
5. List the different types of grammar and define them.
6. Is it true that a non-deterministic PDA is more powerful than a deterministic PDA? Write the reason.
7. Differentiate PDA and TM.
8. Find whether the grammar G has a useless production? $S \rightarrow A$, $A \rightarrow 0A \mid \epsilon$, $B \rightarrow 1A \mid 0B \mid \epsilon$.
9. Is PCP decidable or undecidable? Justify your answer.
10. Define tractable and intractable problems.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Design a DFA that accepts all strings over $\{0, 1\}$ that are divisible by 5 when read as a binary number. (6)
- (ii) Find the equivalent DFA for the following NFA. (7)

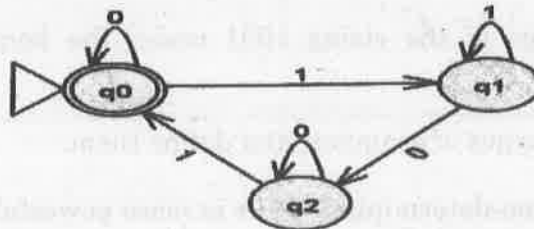


Or

- (b) (i) Construct an NFA for the language $L = \{w \in \{0, 1\}^* \mid w \text{ does not contain either } 00 \text{ or } 11 \text{ as a substring}\}$. Trace the input strings 1010 and 1101. (6)
- (ii) Prove that the language is accepted by an $\mathcal{E}$ -NFA if and only if there exists an equivalent DFA. (7)
12. (a) (i) Prove that if L is a regular language over an alphabet, Σ then $L' = \Sigma^* - L$ is also a regular language. (6)
- (ii) Prove that if $L = L(A)$ for some DFA A , then there is a regular expression R such that $L = L(R)$. (7)

Or

- (b) (i) Show that $L = \{a^n b^n \mid n \geq 1\}$ is not regular. (6)
- (ii) Obtain the regular expression for the following DFA. (7)



13. (a) (i) Show that the grammar $G : S \rightarrow aS \mid aSbS \mid \epsilon$ is ambiguous and find the unambiguous grammar. (6)
- (ii) Construct the PDA P_N to accept the language $L = \{0^n 1^n \mid n \geq 1\}$ by an empty stack and convert it into a P_F accepting by the final state. (7)

Or

- (b) (i) Prove that let $M = (Q, \Sigma, \Gamma, \delta, q_0, z_0)$ be a PDA. Then there is a context-free grammar G such that $L(G) = L(M)$. (6)
- (ii) Convert the grammar $G : S \rightarrow aSb \mid A, A \rightarrow bAa \mid S \mid \epsilon$ into a PDA that accepts the same language by empty stack. Check whether $abab$ belongs to $L(P)$. (7)
14. (a) (i) Prove that the language $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context-free. (6)
- (ii) Write the steps to convert the CFG to CNF. Apply the steps to convert the grammar $G : S \rightarrow AB, A \rightarrow aAA \mid \epsilon, B \rightarrow bBB \mid \epsilon$ into CNF. (7)

Or

- (b) (i) Prove that if L is a context-free language over an alphabet Σ and S is a substring of Σ such that $S(a)$ is a CFL for each a in S , then $S(L)$ is a CFL. (6)
- (ii) Design a Turing Machine that computes the function $f(n) = 2n$, where the input is given as 111, and show how the TM performs the computation. (7)
15. (a) (i) Let the lists A and B be : $A = [ab, a, bab], B = [a, ba, b]$. Determine whether there exists a solution to the MPCP that starts with the first pair (i.e., A_1 and B_1), and if so, provide the sequence of indices that gives a match. If not, justify. (6)
- (ii) Classify and justify whether the following problems are tractable or intractable:
- (1) Sorting a list of integers
 - (2) Solving the Traveling Salesman Problem (TSP) exactly for n cities Apply time complexity analysis. (7)

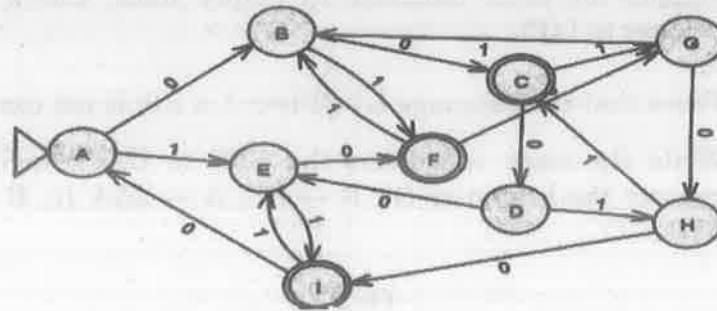
Or

- (b) (i) Apply the definition of NP problems to show whether the Hamiltonian Cycle problem belongs to NP. (6)
- (ii) Apply a heuristic approach (like Nearest Neighbor) to solve a given TSP instance with the following distance matrix: (7)

	A	B	C	D
A	0	10	15	20
B	10	0	35	25
C	15	35	0	30
D	20	25	30	0

PART C — (1 × 15 = 15 marks)

16. (a) Construct a minimal state DFA and find the regular expression for the DFA.



Or

- (b) Design a Turing Machine (TM) that computes:

$$f(m, n) = m - n \text{ if } m \geq n \\ = 0 \text{ otherwise}$$

Simulate their action as input $f(8, 3)$ and $f(5, 7)$.