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Printed Page:-4 **Subject Code:- BCSBS0306Z**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B.Tech
SEM: III - THEORY EXAMINATION (2025 - 2026)
Subject: Formal Language and Automata Theory

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* ***three Sections -A, B, & C.*** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION-A 20

1. Attempt all parts:-

1-a. A language L is accepted by a FSM if it is (CO1 ,K1) 1

(a) CFL
(b) CSL
(c) Recursive
(d) Regular

1-b. Regular expression a*b represents strings (CO1, K2) 1

(a) Zero or more a's followed by one b
(b) One or more b's
(c) One or more a's
(d) a followed by zero

1-c. More than one Parse tree can be generated from a same sentence. The Grammar which has this property are known as:(CO2,K1) 1

(a) Ambiguous
(b) Unambiguous
(c) Ambiguous and Unambiguous
(d) Intersection

1-d. PDA accepts CFLs by : (CO2, K1) 1

(a) Initial state
(b) Transition function
(c) Final state or empty stack
(d) CNF

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1-e. Turing machine is more powerful than:(CO3,K2) 1

(a) Finite automata
(b) Push down automata
(c) Both 1 and 2
(d) None of these

1-f. The primary distinction between a deterministic and a non-deterministic Turing Machine is:(CO3,K1) 1

(a) A non-deterministic machine can have multiple possible transitions for the same input
(b) A deterministic machine has more than one transition for a given input
(c) Non-deterministic machines cannot be simulated by deterministic machines
(d) Deterministic machines cannot halt

1-g. According to Rice Theorem , all non-trivial properties of RE languages are: (CO4,K1) 1

(a) Decidable
(b) Undecidable
(c) Context-free
(d) Regular

1-h. The input to a Universal TM includes: (CO4,K1) 1

(a) Only a string w
(b) Only a TM description M
(c) TM description M and input w
(d) Grammar and PDA

1-i. If P = NP, then: (CO5,K2) 1

(a) All NP-complete problems become easy
(b) Nothing changes
(c) Problems become undecidable
(d) None

1-j. Problem in NP must have:(CO5,K1) 1

(a) Polynomial-time verifier
(b) Polynomial-time solver
(c) Exponential-time verifier
(d) No verifier

2. Attempt all parts:-

2.a. Compare DFA and NFA with respect to their characteristics.(CO1,K4) 2

2.b. Draw a parse tree for the string "aaabbb" using the grammar $S \rightarrow aSb|\epsilon$ (CO2,K3) 2

2.c. Illustrate the components of a Turing Machine.(CO3,K2) 2

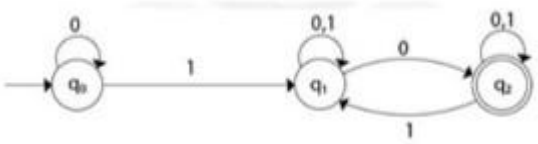
2.d. Analyze the class of undecidable problems and identify any two examples.(CO4,K4) 2

2.e. Differentiate between NP and NP complete. (CO5,K4) 2

SECTION-B 30

3.a. Answer any one of the following:-

3.a.(i) Convert the following NFA into DFA: (CO1, K3) 6



3.a.(ii) Construction of a DFA for the set of string over {a, b} such that length of the string w is divisible by 2 i.e, w mod 2 = 0.(CO1,K3) 6

3.b. Answer any one of the following:-

3.b.(i) Convert the following CFG into Chomsky Normal Form (CNF): S→aB|bA, A→a|aS, B→b|bS. (CO2,K3) 6

3.b.(ii) Summarize the components of a Pushdown Automaton (PDA) using its formal tuple.(CO2,K2) 6

3.c. Answer any one of the following:-

3.c.(i) Prove that recursive languages are closed under Union, Intersection and complement.(CO3,K5) 6

3.c.(ii) Analyze the variants of Turing Machines and briefly describe each.(CO3,K4) 6

3.d. Answer any one of the following:-

3.d.(i) Discuss the concept of decidable language and give atleast two examples of decidable problem.(CO4,K3) 6

3.d.(ii) Compare and contrast a Universal Turing Machine with a standard Turing Machine, and assess the significance of this distinction in the theory of computation.(CO4,K4) 6

3.e. Answer any one of the following:-

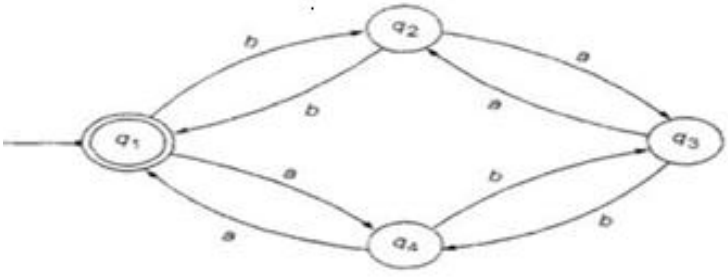
3.e.(i) If P = NP, all of these problems have efficient solutions.Justify the statement.(CO5,K4) 6

3.e.(ii) Explain cook's Theorem and analyze its importance in proving that certain problems are NP-Complete.(CO5,K4) 6

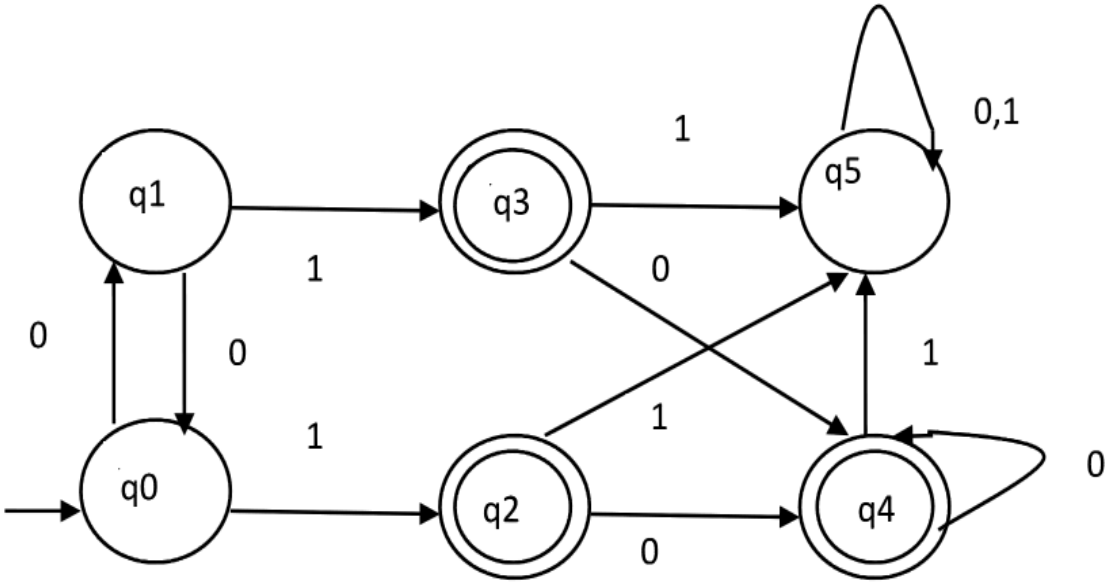
SECTION-C 50

4. Answer any one of the following:-

4-a. Find regular expression for the following Finite Automata using Arden's Theorem (CO1,K3) 10



4-b. Minimize the given DFA shown below: (CO1,K4) 10



5. Answer any one of the following:-

5-a. Explain parse tree. Construct the string 0100110 from the Leftmost and Rightmost derivation.(CO2,K3) 10

S→0S/1AA
A→0/1A/0B
B→1/0BB

b) Find the parse tree for generating the string 11001010 from the given grammar.

S→1B/0A
A→1/1S/0AA
B→0/0S/1BB

5-b. Construct PDA from the following Grammar 10

S→0BB
B→0S/1S/0

Show an ID for the string 010000 is generated for PDA.(CO2,K5)

6. Answer any one of the following:-

6-a. Analyze the closure properties of recursive and recursively enumerable languages (CO3,K4) 10

6-b. Construct a Turing Machine that accepts even palindromes over {a,b}. Explain the logic, transition table, and execution trace for one sample string.(CO3,K3) 10

7. Answer any one of the following:-

7-a. State post correspondence problem.Find whether the list X = (bbab,ab,baa,b) and Y = (a, abbb,aa,bbb) have a post correspondence solution.(CO4,K4) 10

7-b. Analyze the differences between Decidable and undecidable languages .Mention some examples of undecidable problems and elaborate one example.(CO4,K4) 10

8. Answer any one of the following:-

8-a. Discuss the class P and NP in detail. Explain their formal definitions, relationship, significance, and open problems related to P vs NP. Provide suitable examples.(CO5,K4) 10

8-b. Compare and contrast NP -Hard and NP- Complete problems.Prove that 3-SAT is NP-complete.(CO5,K5) 10