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Subject Code:- BMICSE0404

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

M.Tech (Integrated)

SEM: IV - THEORY EXAMINATION (20..... - 20.....)

Subject: Theory of Automata and Formal Languages

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. In given diagram, FSM represents: (CO1, K1) 1

1/0 . 0/1



- (a) Mealy machine
- (b) Moore Machine
- (c) Kleen machine
- (d) All of these

1-b. In a Deterministic Finite Automaton (DFA), for each state and input symbol, there is: (CO1,K1) 1

- (a) No transition
- (b) At most one transition
- (c) Exactly one transition
- (d) More than one transition

1-c. Identify the type of automaton that recognizes regular languages. (CO2, K1) 1

- (a) Finite Automaton
- (b) Pushdown Automaton
- (c) Turing Machine
- (d) Linear Bounded Automaton

1-d. Construct a regular expression for the language consisting of all strings over {0,1} 1

that start with 1. (CO2,K1)

- (a) $1(0+1)^*$
- (b) $(0+1)^*1$
- (c) 0^*1^*
- (d) None of these

- 1-e. Select the root of the parse tree: (CO3,K1) 1
- (a) Production P
 - (b) Terminal T
 - (c) Variable V
 - (d) Starting Variable S
- 1-f. The Grammar can be defined as: $G=(V, \Sigma, P, S)$ In the given definition, what does P represents? (CO3,K1) 1
- (a) Accepting State
 - (b) Sensitive Grammar
 - (c) Starting Variable
 - (d) Production Rules
- 1-g. Limitation of PDA can overcome by: (CO4,K1) 1
- (a) Mealy machine
 - (b) Moore machine
 - (c) Turing machine
 - (d) FA
- 1-h. Analyze the language $L = \{a^n b^n c^n \mid n \geq 1\}$. Can a single-stack PDA accept this language? (CO4, K1) 1
- (a) Yes, by using both acceptance by final state and empty stack
 - (b) Yes, with non-deterministic transitions
 - (c) No, because it requires comparing three symbols with one stack
 - (d) No, because it requires two final states
- 1-i. A Turing Machine (TM) is: (CO5,K1) 1
- (a) A finite state machine with memory
 - (b) A computational model capable of simulating any algorithm
 - (c) A machine with limited processing power
 - (d) A simple calculator for basic arithmetic operations
- 1-j. _____ is a fundamental concept in the Turing machine model. (CO5,K1) 1
- (a) Quantum entanglement
 - (b) Infinite tape
 - (c) Neural networks
 - (d) Bayesian inference

2. Attempt all parts:-

- 2.a. Differentiate between Kleene Closure (Σ^*) and Positive Closure (Σ^+). (CO1, K2) 2
- 2.b. Define regular expression for the language containing all the words over {a,b,c} ending in a. (CO2, K2) 2
- 2.c. Define ambiguous grammar? Give an example. (CO3, K2) 2
- 2.d. Give reason why PDA cannot accept the language $\{a^n b^n c^n d^n, n \geq 0\}$ (CO4, K2) 2
- 2.e. Define Church's Turing Thesis. (CO5, K2) 2

SECTION-B

30

3. Answer any five of the following:-

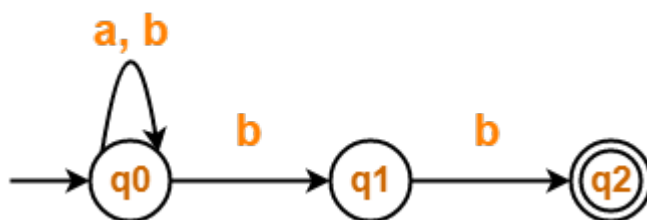
- 3-a. Explain the mathematical model of a finite automaton with an example. (CO1, K2) 6
- 3-b. Construct a Finite automata (DFA) which accepts all binary numbers whose decimal equivalent is divisible by 4 over $\Sigma = \{0, 1\}$. (CO1, K4) 6
- 3-c. State and prove Arden's Theorem. (CO2, K4) 6
- 3-d. Define Regular Grammar. Also, convert given regular grammar to finite automata. $S \rightarrow aS, S \rightarrow bS, S \rightarrow bA, A \rightarrow bB, B \rightarrow aC, C \rightarrow \epsilon$. (CO2, K4) 6
- 3.e. Given the following CFG: (CO3, K4) 6
 $S \rightarrow aA \mid bB \mid C$
 $A \rightarrow a \mid aA \mid B$
 $B \rightarrow b \mid Bb \mid C$
 $C \rightarrow cC \mid c$
 a) Identify and remove the useless symbols from the grammar.
 b) Eliminate unit productions from the resulting grammar.
- 3.f. Describe a two-stack PDA and explain its working with a suitable example. (CO4, K2) 6
- 3.g. Explain Post Correspondence Problem (PCP) (CO5, K2) 6

SECTION-C

50

4. Answer any one of the following:-

- 4-a. i) Convert the following Non-Deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA) 10



- ii) Design a DFA over the alphabet $\{0,1\}$ that accepts all strings ending with "0001". (CO1, K4)

- 4-b. Explain the mathematical model of Mealy machine and Moore machine. 10

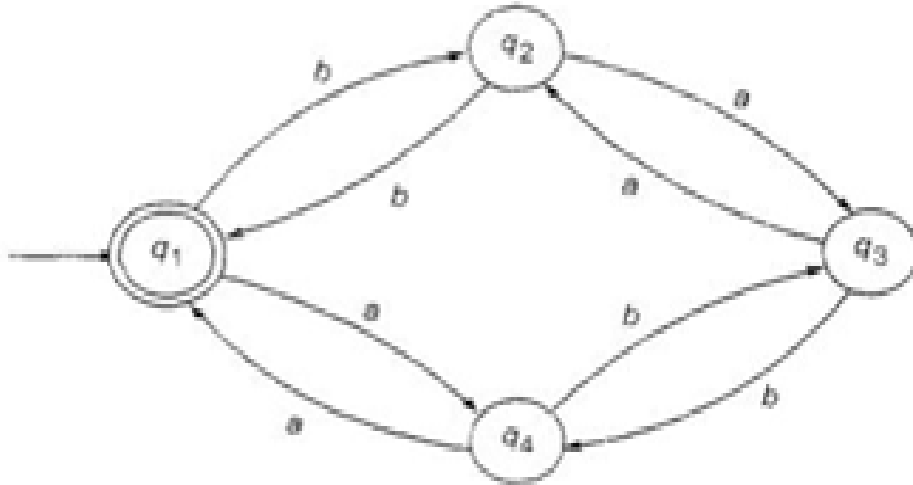
(CO1, K2)

5. Answer any one of the following:-

5-a. Write short note on: (CO2, K2) 10

- (a) Closure properties of Regular Language
- (b) Decision Properties of regular Language

5-b. Find the solution of DFA using Arden's theorem. (CO2, K4) 10



6. Answer any one of the following:-

6-a. Compare Chomsky normal form (CNF) and Greibach Normal form (GNF). 10
Convert the given CFG into CNF: (CO3, K4)

$S \rightarrow aSa \mid bSb \mid a \mid b$

6-b. Consider the grammar G, whose productions are: (CO3, K4) 10

$S \rightarrow aB \mid bA, A \rightarrow a \mid aS \mid bAA, B \rightarrow b \mid bS \mid aBB$

.Find a) Leftmost b) rightmost derivation for string for the string baaabbabba and construct derivation tree also.

7. Answer any one of the following:-

7-a. Explain Pushdown Automata and analyze how its power compares to Finite Automata. Also, design a PDA for $L = \{ a^{m+n}b^m c^n \mid m, n > 1 \}$. 10
(CO4, K4)

7-b. Explain Pushdown Automata. Also, construct a PDA that accepts all strings containing an equal number of 0's and 1's. 10
(CO4, K4)

8. Answer any one of the following:-

8-a. Write short notes on: (CO5, K2) 10
i) Universal Turing Machine
ii) Variants of Turing machine

8-b. Explain the Turing machine. Construct the Turing machine for the language $L = \{ a^n b^n c^n \mid n \geq 1 \}$. 10
(CO5, K4)