Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2023

CS3CO38 / CS3CO10 Theory of Computation

Programme: B.Tech. Branch/Specialisation: CSE / All

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Which one is not a closure property of regular language? **1**

(a) Union of regular language is regular

(b) Intersection of regular language is regular

(c) Reversal of regular language closed under regular

(d) None of these

ii. Pick the correct statement about Moore and Mealy machine: **1**

(a) The output is function of input and current state in Moore machine

(b) The output is function of input and current state in Mealy machine.

(c) The length of output string is higher then length of input string in Mealy machine.

(d) The length of output string is lesser then length of input string in Moore machine.

iii. Transition function maps Q X Σ into 2^Q in which kind of automaton $M=(Q, \Sigma, \delta, q_0, F)$ **1**

(a) Deterministic automaton

(b) Non-deterministic automaton

(c) All kind of finite state automaton

(d) None of these

iv. After accepting the string, the automaton **1**

(a) Halt in any state (b) Halt in any non-final state

(c) Halt in final state (d) All of these

v. As per Chomsky hierarchy the type-2 is- **1**

(a) Regular grammar (b) Context free grammar

(c) Context sensitive grammar (d) Unrestricted grammar

P.T.O.

vi. Which production is applicable in both CNF and GNF (Where A,B,C are non-terminal symbols, a is Terminal symbol)? **1**
(a) A → a (b) A→ BC
(c) A → aB (d) None of these

vii. A pushdown automaton recognizes- **1**
(a) Context free language
(b) Recursively enumerable language
(c) Recursive language
(d) All of these

viii. A pushdown automaton has- **1**
(a) Only stack
(b) A tape, a controller and a stack
(c) A tape, A controller
(d) A tape and a stack

ix. The automaton which recognize context-sensitive languages is- **1**
(a) Finite state automaton
(b) Pushdown automaton
(c) Linear bounded automaton
(d) All of these

x. In transition function δ(q,0) = (p, X, L) of Turing machine X and L are respectively- **1**
(a) Input symbol and direction
(b) Input symbol and tape symbol
(c) Tape symbol and input symbol
(d) Tape symbol and direction

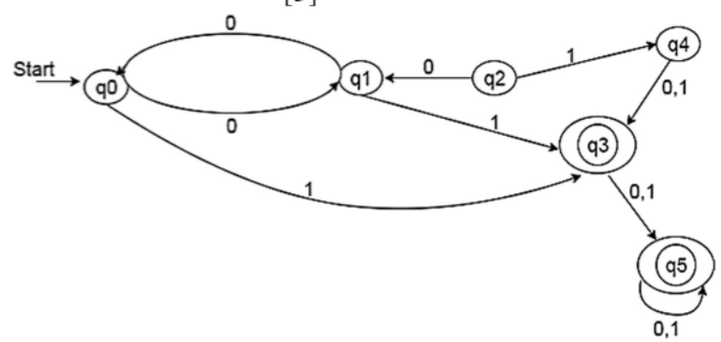
Q.2 i. Explain Kleen's star and Kleen's positive closure. Give example of each. **4**

ii. (a) Define regular expression for regular language. **6**
(b) Construct FSA for regular expression as given below:
R = ab+(b+aa)b*a

OR iii. Explain Moore Machine and Mealy machine with formal definition and diagram of each. **6**

Q.3 i. Explain non-deterministic automaton with formal definition and transition diagram. **4**

ii. Minimize FSA as given in figure. Also write tuples and draw transition diagram of minimized automaton. **6**



OR iii. (a) Write pumping lemma for regular language. **6**
(b) Use pumping lemma to prove that language L={$a^n b^n$; n >0) is not a regular language .

Q.4 i. Explain Chomsky Hierarchy with relationship diagram. **4**

ii. (a) What is simplified grammar? **6**
(b) Eliminate ε - production from following CFG and rewrite CFG.
G=({A,B,C,D},{a,b},P,S)
S→ ABCD
A→ Cda
B→ Cb
C→ a | ε
D → bD | ε

OR iii. What is grammar in CNF and in GNF? Explain each with example. **6**

Q.5 i. Compare pushdown automaton with finite sate automaton. **4**

ii. Construct a PDA for the following grammar **6**
S → aB/B
B → aS /bS / a
and check the acceptability of string aabbb.

OR iii. Design Pushdown automaton for the following CFL. Also write its tuples and draw transition diagram. **6**
L = { $a^n b^n c^m$ | n,m>=1 }

Q.6 Attempt any two:

i. Explain Turing machine with its formal definition. **5**

ii. Explain recursive and recursively enumerable language. **5**

iii. Design a Turing machine and Draw its transition diagram for the language which consist even number of a in {a,b}*. **5**

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Marking Scheme

Theory of Computation - CS3CO38

Q.1 i) Which one is not a closure property of Regular Language **1**
d. None of the above.

ii) Pick the correct statement about Moore and Mealy machine **1**
b. The output is function of input and current state in Mealy machine.

iii) Transition function maps Q X Σ into 2^Q in which kind of automaton M=(Q, Σ, δ, q_0,F) **1**
b. Non-Deterministic Automaton

iv) After accepting the string, the automaton **1**
c. Halt in final state

v) As per Chomsky hierarchy the type-2 is **1**
b. Context Free Grammar

vi) Which production is applicable in both CNF and GNF **1**
(Where A,B,C are non-terminal symbols , a is Terminal symbol)
a. A → a

vii) A pushdown automaton recognize **1**
a. Context free language

viii) A pushdown automaton has **1**
b. A tape, A controller and a Stack

ix) The automaton which recognize context-sensitive languages is **1**
c. Linear Bounded Automaton

x) In transition function δ(q,0) = (p, X, L) of Turing machine X and L are respectively **1**
d. Tape symbol and direction

Q.2 i. Explain Kleen's star and Kleen's positive closure. Give example of each. **4**
Kleen's star closure with example **2-Marks**
Kleen's positive closure with example **2-Marks**

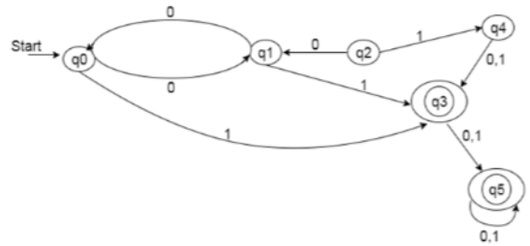
ii. a. Define regular expression for regular language. **2-Marks** **6**
b. Construct FSA for regular expression as given below.
R = ab+(b+aa)b*a **4-Marks**

OR iii. Explain Moore Machine and Mealy machine with formal **6**

definition and diagram of each.
Moore Machine with formal definition and diagram **3-Marks**
Mealy Machine with formal definition and diagram **3-Marks**

Q.3 i. Explain non-deterministic automaton with formal definition and transition diagram. **4**
Explanation: **1-Mark**
Formal definition and transition diagram. **3-Mark**

ii. Minimize FSA as given in figure by Myhill-Nerode (Table fill) Method). Also write tuples and draw transition diagram of minimized automaton. **6**



Minimization **4-Marks**
Tuples and Transition Diagram/ table **1-Mark for each**

OR iii. a. Write pumping lemma for regular language. **3-Marks** **6**
b. Use pumping lemma to prove that language L={$a^n b^n$; n >0) is not a regular language . **3-Marks**

Q.4 i. Explain Chomsky Hierarchy with relationship diagram. **4**
Explanation **2-Marks**
Relationship diagram. **2-Marks**

ii. a. What is simplified grammar ? 2**-Marks** **6**
b. Eliminate ε - production from following CFG and rewrite CFG.
G=({A,B,C,D},{a,b},P,S)
S→ ABCD
A→ Cda
B→ Cb
C→ a | ε

$D \rightarrow bD \mid \varepsilon$ **4-Marks**

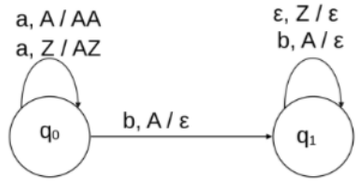
OR iii. What is Grammar in CNF and in GNF ? Explain each with example. **6**

CNF with example **3-Marks (Definition 2 -Marks, Example 1-Mark)s**

GNF with example **3-Marks**

Q.5 i. Compare pushdown automaton with finite sate automaton. **4**

At least 2 comparison : **2-Marks each**



ii. Find the acceptability of string **aabbb** on **6**

PDA = ({q0,q1},{a,b},{A,Z}, δ, q0, Z, {})

Procedure **4-Marks**

Acceptability conclusion **2-Marks**

OR iii. Design Pushdown automaton for the following CFL. Also write its tuples and draw transition diagram. **6**

$L = \{ a^n b^n c^m \mid n,m>=1 \}$

Designing 3-**Marks**

Tuples **1-Marks**

Transition Diagram **2- Marks**

Q.6 Attempt any two:

i. Explain Turing Machine with it formal definition. **5-Marks** **5**

Formal Definition with table 3 Marks , physical diagram -2 marks

ii. Explain Recursive and Recursively Enumerable Language ? **5**

2.5 Marks for each

iii. Design a Turing machine and Draw its transition diagram for the language which consist even number of **a** in {a,b}*. **5**

Design Procedure **3-Marks**

Transition Diagram **2-Marks**

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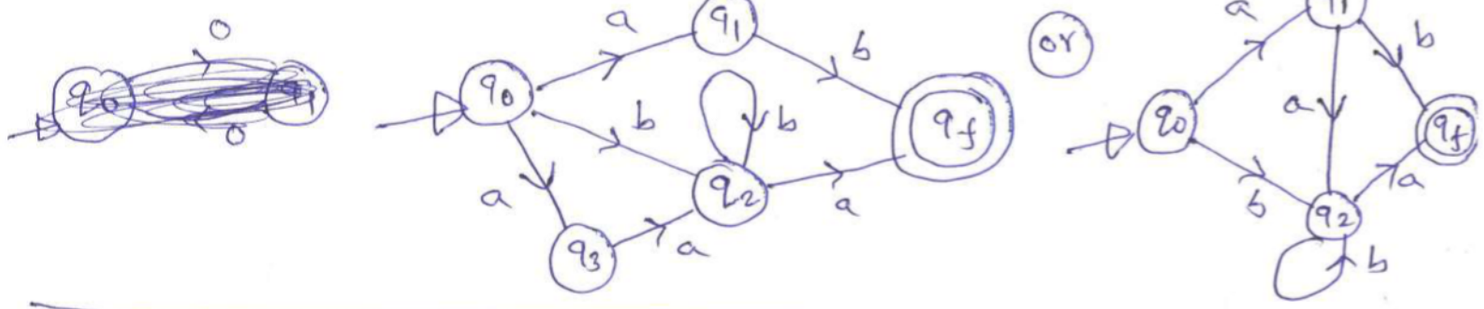
TOC [CS3C038/10]

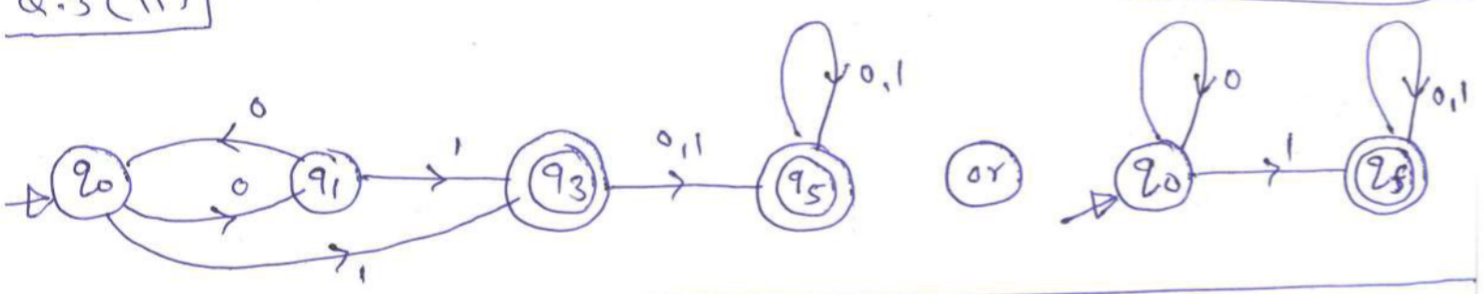
Scheme Varification

MCQ ⇒ 1-D, 2-B, 3-B, 4-C, 5-B, 6-A, 7-A, 8-B, 9-C, 10-I

Q.2(ii-b) RE = $ab+(b+aa)b^*a$



Q.3(ii)



Q.5(ii-b) $S \to aB/B \qquad B \to aS/bS/a$

⇓ convert into GNF

$S \to aB/aS/bS/a$ & $B \to aS/bS/a$

⇓ Convert (construct) PDA

R_1:- $\delta(q, \in, S) = \{(q, aB), (q, aS), (q, bS), (q, a)\}$

R_2:- $\delta(q, \in, B) = \{(q, aS), (q, bS), (q, a)\}$

R_3: $\delta(q, a, a) = \{(q, \in)\}$ & R_4:- $\delta(q, b, b) = \{(q, \in)\}$

Q.4(ii-b) $G \Rightarrow (V_n, \Sigma, P, S)$

$V_n = \{A, B, G, D\}$, $\Sigma = \{a, b, d\}$, $S = \{S\}$

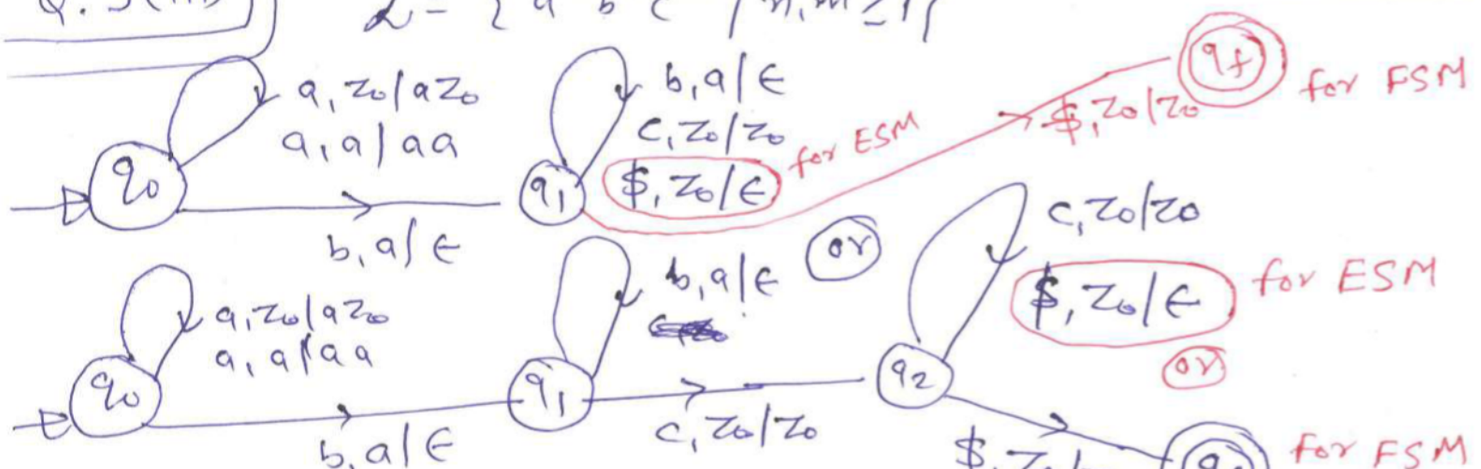
$P \Rightarrow \{ S \to ABGD,\ A \to Gda,\ B \to Gb,\ G \to a/\epsilon,\ D \to bD/\epsilon \}$

Soln $G' = (V_n', \Sigma', P', S)$

$P' \Rightarrow \{ S \to ABGD / ABG / ABD / AB$

$A \to Gda / da,\quad B \to Gb / b,\quad G \to a,\quad D \to bD / b \}$

Q.5(iii) $L = \{ a^n b^n c^m / n, m \geq 1 \}$



Q.6(iii)