Q.5 i. Write pumping lemma for context free language. **4**

ii. Write answer of following- **6**

(a) Condition for PDA to be deterministic

(b) Condition for PDA accept string by final state

(c) Condition for PDA accept string by empty stack

OR iii. Consider Push down automata- **6**

P({q0,q1},{a,b,c},{a,b,Z},δ, q0, Z, ∅)

$\delta(q0, a, Z) = (q0, aZ)$

$\delta(q0, b, Z) = (q0, bZ)$

$\delta(q0, a, a) = (q0, aa)$

$\delta(q0, a, b) = (q0, ab)$

$\delta(q0, b, b) = (q0, bb)$

$\delta(q0, b, a) = (q0, ba)$

$\delta(q0, c, a) = (q1, a)$

$\delta(q0, c, b) = (q1, b)$

$\delta(q1, a, a) = (q1, \varepsilon)$

$\delta(q1, b, b) = (q1, \varepsilon)$

$\delta(q1, \varepsilon, Z) = (q1, \varepsilon)$

Use instantaneous descriptions to determine acceptability of string ω = abcba. [Write comments String is accepted or rejected. If accepted then accepted by empty stack or accepted by final state]

Q.6 Attempt any two:

i. What is Turing machine. Describe its construction and write formal definition. **5**

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

iii. Write short notes on universal Turing machine. **5**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering / Science

End Sem Examination May-2024

CS3CO38 / BC3CO64 Theory of Computation

Programme: B.Tech. / B.Sc. Branch/Specialisation: CSE All/ Computer Science

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. If L={ab,aa} then its Kleen's closure L*will contain- **1**

(a) abaa (b) aaab (c) aaaa (d) All of these

ii. Regular expression R = 0*1* represent regular language- **1**

(a) $L=\{0^n1^n \mid n \geq 0\}$ (b) $L=\{0^n1^m \mid n,m \geq 0\}$

(c) $l=\{0^n1^m \mid n,m \geq 1\}$ (d) $L=\{01\}^n \mid n \geq 0\}$

iii. Pick false statement – **1**

(where Q: Set of states, Σ: Set of input alphabet}

(a) Transition function of non-deterministic finite state automata maps Q X Σ into 2^Q

(b) Finite state automata recognises regular language.

(c) Non-deterministic finite state automata is more powerful than deterministic automata

(d) Transition function of deterministic finite state automata maps Q X Σ into Q

iv. Which one of the following is transition function of NDFA **1**

(a) $\delta(q_0, a) = q_1$

(b) $\delta(q_0, a) = q_1$ and $\delta(q_0, b) = q_1$

(c) $\delta(q_0, a) = q_1$ and $\delta(q_0, a) = q_2$

(d) $\delta(q_0, a) = q_1$ and $\delta(q_0, b) = q_2$

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

(a) Regular grammar

(b) Context free grammar

(c) Context sensitive grammar

(d) Unrestricted grammar

vi. Which one of the following is unit production? **1**
(where A,B,C are non-terminals, 1 is terminal symbol)
(a) A -> 1 (b) A -> ε (c) A -> BC (d) A -> B

vii. Which of the following describe deterministic PDA? **1**
(a) $\delta(q_0, a, X) = \{(q_0, aX)\}$
$\delta(q_0, \varepsilon, X) = \{(q_0, X)\}$
(b) $\delta(q_0, a, X) = \{(q_0, aX), (q_0, \varepsilon)\}$
(c) $\delta(q_0, a, X) = \{(q_0, aX)\}$
$\delta(q_0, a, Y) = \{(q_0, aY)\}$
(d) None 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

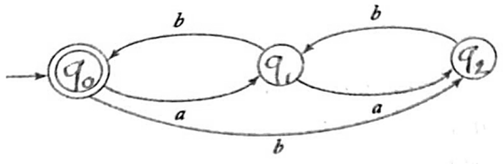
ix. Pick the correct statement- **1**
(a) Turing machine has infinite length tape
(b) Linear bounded automata recognise context sensitive language
(c) Turing machine may enter into infinite loop
(d) All of these

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

Q.2 i. What is Kleene's closure. **2**

ii. Describe Moore machine. Draw transition diagram of it in support of example. **3**

iii. A transition diagram of FSA is given as below- **5**



Answer followings-
(a) Write tuples of given FSA
(b) Find acceptability of string ω = aabb
(c) Find acceptability of string ω = aaabb

OR iv. What are closure properties of regular language. Explain any five. **5**

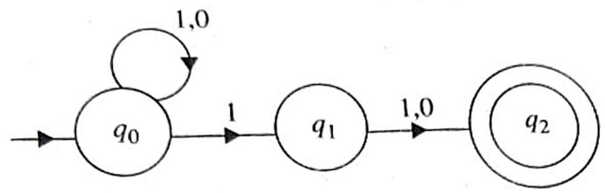
Q.3 i. Why a FSA is said to be non-deterministic? Support your answer by drawing a transition diagram. **4**

ii. Consider FSA M= ({q1,q2, q3, q4,q5},{0,1}, δ, q1,{q3,q5}) where δ are given by transition table as given below- **6**

δ	0	1
→ q_1	q_2	q_3
q_2	q_3	q_5
*q_3	q_4	q_3
q_4	q_3	q_5
*q_5	q_2	q_5

Construct minimum state automata equivalent to given FSA. Draw transition diagram of minimized automata.

OR iii. Consider non-deterministic FSA, M= ({q0,q1,q2},{0,1}, δ, q0,{q2} **6**



Construct deterministic FSA equivalent to given non-deterministic FSA. Draw transition diagram.

Q.4 i. Explain with example Chomsky normal form and Graibach normal form. **4**

ii. (a) What is simplified grammar? Explain. **6**
(b) Remove null production from CFG whose productions are given below. Also write all production after removing null production.
S -> ABaC
A-> BC
B->b | ε
C-> D | ε
D-> d

OR iii. Use CYK algorithm to determine whether the string ω = aabbb is in language generated by the grammar. **6**
S-> AB
A-> BB|a
B-> AB|b

Scheme of Marking
Theory of Computation-CS3CO38(T)-BC3CO64

Q.1 i) If L={ab,aa} then its kleen's closure L*will contain **1**
d. All of the above

ii) Regular expression R = **0*1*** represent regular language **1**
(b) L={0_n1_m | n,m ≥ 0 }

iii) Pick false statement **1**
(Where Q : Set of states, Σ: Set of input alphabet}
c. Non-deterministic finite state automata is more powerful than Deterministic automata.

iv) Which one of the following is transition function of NDFA **1**
c. $\delta(q_0, a) = q_1$ and $\delta(q_0, a) = q_2$

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

vi) Which one of the following is unit production **1**
(Where A,B,C are non-terminals, 1 is terminal symbol)
d. A -> B

vii) Which of the following describe deterministic PDA **1**
c. $\delta(q_0, a, X) = \{(q_0, aX)\}$
$\delta(q_0, a, Y) = \{(q_0, aY)\}$

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

ix) Pick the correct statement **1**
d. All of the above.

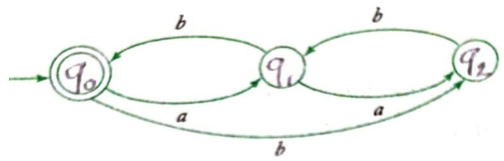
x) Consider transition function of Turing machine **1**
$\delta(q,0) = (p, X, L)$
X and L are respectively
d. Tape symbol and direction of head

Q.2 i. Write formal definition of Finite state Automata. **2**
Tuples 1-Mark
Description of tuple 1-Mark

ii. Describe Moore machine. Also draw transition diagram of it in support of example. **3**

Describe Moore machine. 2-Marks
Example 1-Mark

iii. A transition diagram of FSA is given as below **5**



Answer followings
(I) Write tuples of given FSA. 1-Mark
(II) Find acceptability of string ω = aabb 2-Marks
(III) Find acceptability of string ω = aaabb 2-Marks

OR iv. What are closure properties of Regular Language. Explain any five. **5**
For each correct statement 1-Mark

Q.3 i. Why a FSA is said to be Non-Deterministic? Support your answer by drawing a transition diagram. **4**

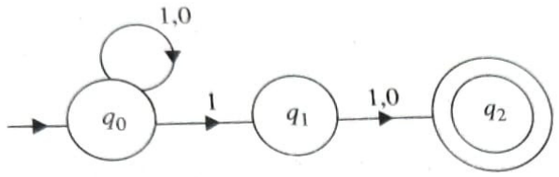
Explanation or definition of NDFA 2-Marks
Example Transition diagram showing Non-Determinism 2-Marks

ii. Consider FSA M=({q1,q2, q3, q4,q5},{0,1}, δ, q1,{q3,q5}) where δ are given by transition table as given below **6**

δ	0	1
→ q_1	q_2	q_3
q_2	q_3	q_5
*q_3	q_4	q_3
q_4	q_3	q_5
*q_5	q_2	q_5

Construct minimum state automata equivalent to given FSA. Also draw transition diagram of minimized automata.
Construction and procedure 4-Marks
Transition diagram of Minimized automata 2-Marks

OR iii. Consider Non-Deterministic FSA **6**
M=({q0,q1,q2},{0,1}, δ, q0,{q2}



Construct Deterministic FSA equivalent to given Non-Deterministic FSA. Also draw transition diagram.

Construction and procedure 4-Marks
Transition diagram of equivalent DFA 2-Marks

Q.4 i. Explain with example Chomsky Normal form and Graibach Normal Form. **4**

Chomsky Normal Form 2 Marks
Graibach Normal Form 2 Marks

ii. (a) What is simplified grammar? Explain. **6**
(b) Remove null production from CFG whose productions are given below. Also write all production after removing null production.

S -> ABaC
A-> BC
B->b | ε
C-> D | ε
D-> d

Definition of Simplified Grammar 2-Marks
Removing Procedure 3-Marks
Productions after removing null production 1-Mark

OR iii. Use CYK algorithm to determine whether the string ω = aabbb is in language generated by the grammar **6**

S-> AB
A-> BB|a
B-> AB|b

Procedure 4-Marks
Statement whether the string generated by grammar or not 2-Mark

Q.5 i. Write pumping Lemma for Context Free Language. 4-Marks **4**

ii. Write answer of following **6**
(a) Condition for PDA to be Deterministic 2-Marks
(b) Condition for PDA accept string by final state. 2-Marks
(c) Condition for PDA accept string by empty stack. 2-Marks

OR iii. Consider Push down automata **6**

P({q0,q1},{a,b,c},{a,b,Z},δ, q0, Z, ∅)

$$\delta(q0, a, Z) = (q0, aZ)$$
$$\delta(q0, b, Z) = (q0, bZ)$$
$$\delta(q0, a, a) = (q0, aa)$$
$$\delta(q0, a, b) = (q0, ab)$$
$$\delta(q0, b, b) = (q0, bb)$$
$$\delta(q0, b, a) = (q0, ba)$$
$$\delta(q0, c, a) = (q1, a)$$
$$\delta(q0, c, b) = (q1, b)$$
$$\delta(q1, a, a) = (q1, \varepsilon)$$
$$\delta(q1, b, b) = (q1, \varepsilon)$$
$$\delta(q1, \varepsilon, Z) = (q1, \varepsilon)$$

Use instantaneous descriptions to determine acceptability of string ω = abcba. [Write comments String is accepted or rejected. If accepted then accepted by empty stack or accepted by final state]
Computation for determining acceptability 4-Marks
Comments on acceptability 2-Marks

Q.6 Attempt any two:

i. What is Turing Machine. Describe its construction and write formal definition. **5**
Describing construction 3-Marks
Formal Definition 2-Marks

ii. Explain Recursively Enumerable language and recursive language. **5**
2.5 Marks for each

iii. Write short notes on universal Turing Machine. 5-Marks **5**

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[2]

[3]

P.T.O.