OR iii. Describe following variant of Turing Machine- **6**
(a) Multi tape Turing Machine
(b) Multi track Turing machine

Q.6 Attempt any two:
i. Write short notes on Universal Turing Machine. **5**
ii. Explain undecidable problem and Turing Machine halting problem. **5**
iii. Explain P class and NP class problem. Also give example of each. **5**

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

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
CB3CO22 Formal Language & Automata Theory
Programme: B.Tech. Branch/Specialisation: CSBS

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. In FSA M=({q0,q1}, {a,b}, δ, q0, {q0}), Start and final states are respectively- **1**
(a) q0, q1 (b) q1,q0 (c) q1, q1 (d) q0,q0

ii. Maximum number of states in equivalent DFA, if NDFA has p number of states- **1**
(a) p (b) $2^{(p-1)}$ (c) 2^p (d) $2^p - 1$

iii. Pick the correct statement- **1**
(a) Context Free Grammar is sub-set of Regular Grammar
(b) By the pumping lemma for regular language, it is always possible to prove that a language is regular
(c) Complement of Regular Language is Regular.
(d) A language which can only be generated from context free grammar, can also be generated from regular grammar

iv. Which of the following production does not belongs to GNF? **1**
(Where V and A are variables, a is terminal symbol)
(a) V -> a (b) V -> Aa (c) V-> aA (d) v -> aAA

v. If $\beta \rightarrow \gamma$ be a production of CSG than- **1**
I. $|\beta| \leq |\gamma|$
II. $|\beta| \geq |\gamma|$
III. $\beta, \gamma \in (V \cup T)^+$
IV. $\beta, \gamma \in (V \cup T)^*$
Which of above are correct?
(a) I and III (b) II and IV (c) I and IV (d) Only I

vi. As compared to Linear Bounded Automata, Pushdown automata has- **1**
(a) Stack (b) Infinite length tape
(c) Read/ Write head (d) All of these

P.T.O.

vii. A Turing Machine is capable of- **1**
(a) Accept a formal language
(b) Produce a output
(c) Enumerate strings of language
(d) All of these

viii. A basic Turing Machine has- **1**
(a) Bounded workspace but infinite length tape
(b) Unbounded workspace but finite length tape
(c) Unbounded workspace and infinite length tape
(d) None of these

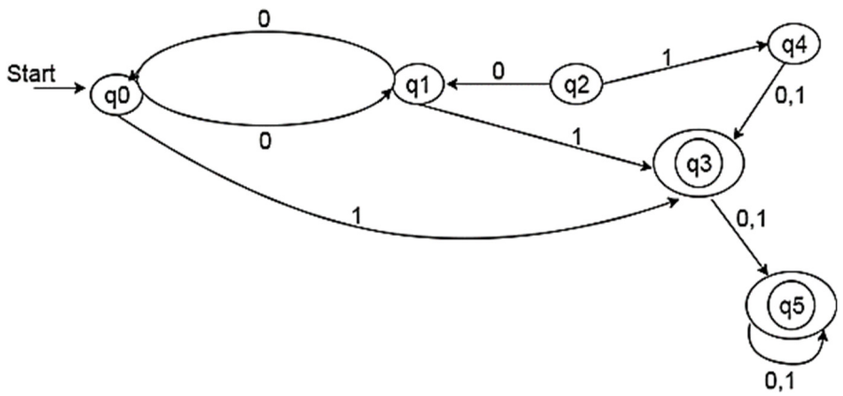
ix. Problems which are solvable and Tractable in polynomial time is- **1**
(a) P class problem (b) NP class problem
(c) NP Hard class problem (d) None of these

x. Sorting Problem is- **1**
(a) P class problem (b) NP hard problem
(c) NP complete problem (d) None of these

Q.2 i. Explain production and derivation. Give suitable example of each. **2**

ii. What is chomsky hierarchy? Explain with diagram. **3**

iii. Minimise following FSA by table filled (Myhill-Nerode theorm) method. Also draw transition diagram of minimised FSA. **5**



OR iv. A NDFA is given as below. Construct and draw transition diagram of its equivalent DFA. **5**

NDFA =($\{q_0, q_1, q_2\}$,{0,1},δ, q_0,$\{q_0\}$)

	0	1
->$\{q_0\}$*	$\{q_2\}$	$\{q_1\}$
$\{q_1\}$	$\{q_0,q_2\}$	$\{q_2\}$
$\{q_2\}$	$\{q_2\}$	$\{q_2\}$

Q.3 i. Define regular grammar. Also give its example. **2**

ii. Write any three properties of regular language. **3**

iii. (a) Give formal Definition of CFG. Also write some of its productions as an example. **5**

(b) Show that following grammar is ambiguous by constructing two parse tree that produce string $\omega = aab$.

G = ({S,A,B},{a,b},P, S)
S -> AB|aaB
A -> a|Aa
B -> b

OR iv. (a) Explain Chomsky Normal Form (CNF) and Greibach Normal Form (GNF). **5**

(b) Convert following grammar into CNF.

G = ({S,A,B},{a,b,c},P,S)
S -> ABa
A -> aab
B -> Ac

Q.4 i. Compare Deterministic and Non-deterministic pushdown automata. **4**

ii. Compute input string $\omega = abba$ on given pushdown automata and write comments on acceptability of this string. **6**

P = ($\{q_0, q_1, q_2\}$,{a,b},{a,b,Z}, δ,q_0,Z,$\{q_2\}$))
δ (q_0, a, a) = {(q_0, aa)}
δ (q_0, ε, a) = {(q_1, a)}
δ (q_0, b, a) = {(q_0, ba)}
δ (q_0, ε, b) = {(q_1, b)}
δ (q_0, a, b) = {(q_0, ab)}
δ (q_0, b, b) = {(q_0, bb)}
δ (q_0, a, Z) = {(q_0, aZ)}
δ (q_0, b, Z) = {(q_0, bZ)}
δ (q_1, a, a) = {(q_1, ε)}
δ (q_1, b, b) = {(q_1, ε)}
δ (q_1, ε, Z) = {(q_2, Z)}

OR iii. (a) Describe physical construction of linear bounded automata. **6**

(b) Write formal definition of linear bounded automata.

Q.5 i. Define Turing recognizable and Turing decidable language. **4**

ii. Design Turing Machine for Language as given below. **6**

$L = \{a^n b^n \mid n>0\}$

Marking Scheme

Formal Language and Automata Theory-CB3CO22(T)

Q.1	i)	d. q0,q0		**1**
	ii)	d. 2^p -1		**1**
	iii)	c. Complement of Regular Language is Regular.		**1**
	iv)	b. V -> Aa		**1**
	v)	a. I and III		**1**
	vi)	a. Stack		**1**
	vii)	d. All of the above		**1**
	viii)	c. Unbounded and infinite length tape		**1**
	ix)	Problems which are solvable and Tractable in polynomial time is .) P class problem		**1**
	x)	Sorting Problem is a. a,b,c all are correct.		**1**
Q.2	i.	Production and derivation	(1 Mark*2)	**2**
	ii.	Explanation :	1-Mark	**3**
		Diagram:	2-Marks	
	iii.	Procedure :	3-Marks	**5**
		Transition Diagram :	2-Marks	
OR	iv.			**5**
		Construction Procedure:	3-Marks	
		Transition Diagram :	2-Mark	
Q.3	i.	Formal Definition with example :	2-Marks	**2**
	ii.	Three properties of regular language	(1 Mark*3)	**3**
OR	iii.	(a) Formal Definition with example :	2-Mark	**5**
		(b) Parse Tree :	3-Marks	
		(a) Explain …….. Form (GNF).	(1 Mark*2)	**5**
		(b) Convert following grammar into CNF.	3-Marks	
Q.4	i.			
	ii.	Deterministic …… automata.	(2 Mark*2)	**4**
OR	iii.	Instantaneous Description:	4-Marks	**6**
		Comment of acceptability:	2-Marks	
		(a) Physical …… automata.	3 Marks	**6**
		(b) Formal ……. automata.	3 Marks	
Q.5	i.			
	ii.	Define Turing recognizable	2 Marks	**4**
		Turing decidable language.	2-Marks	
OR	iii.	Procedure	4-Marks	**6**
		Transition Diagram/ Transition Table	2-Marks	
		(a) Multi tape Turing Machine	3 Marks	**6**
		(b) Multi track Turing machine	3-Marks	
Q.6				
	i.	**Attempt any two:**		
	ii.	Universal Turing Machine.	(As per explanation)	**5**
	iii.	Undecidable Problem :	2- Marks	**5**
		Turing Machine halting Problem:	3- Marks	
	iv.	P class and NP class problem.	2.5 Marks	**5**
		Example	2.5 Marks	

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