Course Code: CS354TA

USN										

R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU)

V Semester B.E

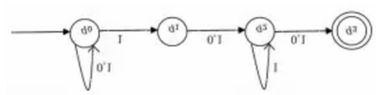
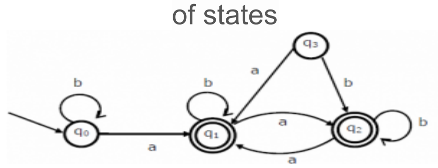
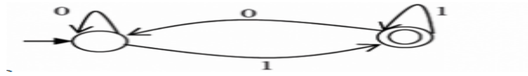
Model Question paper

THEORY OF COMPUTATION

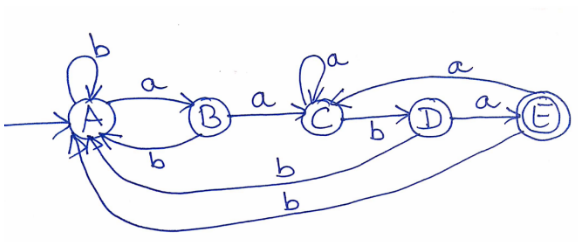
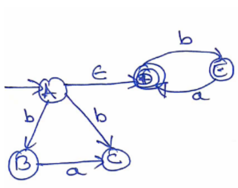
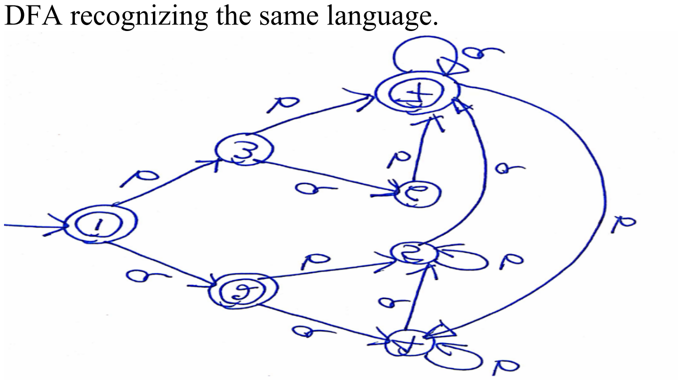
Time: 03 Hours ***Maximum Marks: 100***

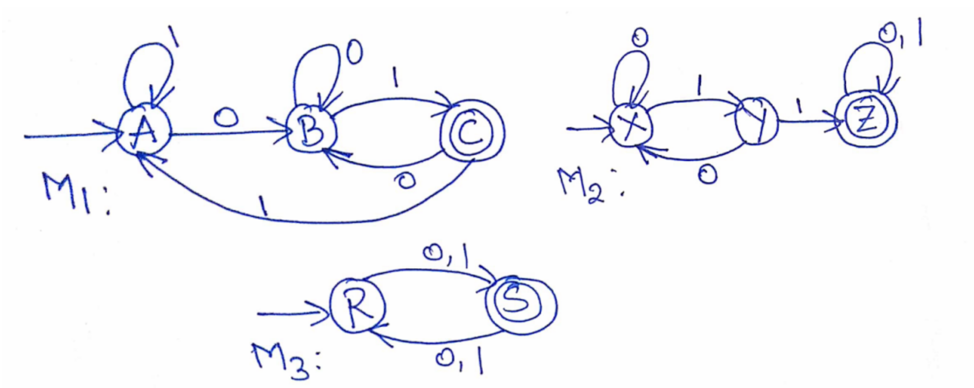
Instructions to Candidate:

1. **Answer all questions from PART-A. PART-A questions to be answered in first three pages of the answer book.**
2. **Answer question 2 and any one question from 3 and 4, any one question from 5 and 6, any one question from 7 and 8 AND any one question from 9 and 10 PART-B.**

	PART-A	
1.1	Consider the following automata. What is the set of reachable states for the input string 0011? 	**1**
1.2	The minimum state automaton equivalent to the below FA has how many number of states 	**1**
1.3	Find R^{2}_{12}=? 	**1**
1.4	Define ε –closure (q), where q ε Q of an automata.	**1**
1.5	In each case, find a string of minimum length in ∑= {0, 1} not in the language corresponding to the given regular expression. i. $(0^*+1^*)(0^*+1^*)(0^*+1^*)$ ii. $0^*(100^*)^*1^*$	**1**

<table>
<tr><td>1.6</td><td>Describe the decision algorithm to answer the following question.
Given two DFA's M1 and M2, are there any strings that are accepted by neither?</td><td>1</td></tr>
<tr><td>1.7</td><td>Give CFG for the language "The set of odd length strings in {a, b}* with the middle symbol a".</td><td>1</td></tr>
<tr><td>1.8</td><td>Show that the grammar with indicated productions is ambiguous.
S→aSb | aaSb | ϵ</td><td>1</td></tr>
<tr><td>1.9</td><td>Define Left Most Derivation (LMD).
Give LMD for abaaba in the grammar with productions
S→aSaSbS | aSbSaS |bSaSaS | ϵ</td><td>1</td></tr>
<tr><td>1.10</td><td>Identify the nullable variables in the grammar given below.
S→AB|ABC, A→BA|BC|a| ϵ, B→AC|CB|b|ϵ, C→AB|BC|c</td><td>1</td></tr>
<tr><td>1.11</td><td>If G is a context free grammar in CNF and x ϵ L(G) with |x|=n. How many steps are there in the derivation of x in G?</td><td>1</td></tr>
<tr><td>1.12</td><td>Let G be the CFG with productions S→S+S|S-S|S*S|S/S|(S)|a
How many derivation strings are there for the string a+(a*a)/a-a?</td><td>1</td></tr>
<tr><td>1.13</td><td>DFA whose transition table is as below, here state A is the start state and states B, C are final states.
<table><tr><td>δ</td><td>a</td><td>b</td></tr><tr><td>A</td><td>B</td><td>B</td></tr><tr><td>B</td><td>C</td><td>C</td></tr><tr><td>C</td><td>D</td><td>D</td></tr><tr><td>D</td><td>A</td><td>B</td></tr></table>What is the equivalent left linear grammar for the above DFA.</td><td>1</td></tr>
<tr><td>1.14</td><td>Consider the right linear grammar with the productions
A→aB | bD, B→aB | bC | €, C→aB | bC | €, D→aD | bD
Find the left linear grammar which is equivalent to the above right linear grammar.</td><td>1</td></tr>
<tr><td>1.15</td><td>Define Deterministic Push Down Automata.</td><td>1</td></tr>
<tr><td>1.16</td><td>What is the language generated by the Context Sensitive Grammar with the productions S→ABCS | ABC, AB→BA, AC→CA, BC→CB, BA→AB, CA→AC, CB→BC, A→a, B→b, C→c.</td><td>1</td></tr>
<tr><td>1.17</td><td>Obtain Turing Machine to accepts the language
L={w| w ϵ {a, b}* and w ends with abb}.</td><td>1</td></tr>
<tr><td>1.18</td><td>What is the language generated by the right linear grammar with productions
S→aA | bC | b, B→aC | bA | a, A→aS | bB, C→aB | bS.</td><td>1</td></tr>
<tr><td>1.19</td><td>If L1 and L2 are recursively enumerable languages, then L1∩ L2 is recursively enumerable language. Is this statement is TRUE or FALE.</td><td>1</td></tr>
<tr><td>1.20</td><td>What is the solution to the instance of PCP given below.
<table><tr><td></td><td>List A</td><td>List B</td></tr><tr><td></td><td>Xi</td><td>Yi</td></tr><tr><td>1</td><td>1</td><td>010</td></tr><tr><td>2</td><td>0</td><td>10</td></tr><tr><td>3</td><td>10</td><td>101</td></tr><tr><td>4</td><td>01</td><td>100</td></tr></table></td><td>1</td></tr>
</table>

	PART-B	
2 a	Find the regular expressions corresponding to each of the following subsets of $\{0,1\}^*$. a) The language of all strings containing exactly two 0's. b) The language of all strings that do not end with 01.	**4**
b	For the DFA below describe, either in words or by writing regular expressions, the strings that cause the DFA to be in each state. 	**4**
c	Explain the algorithm to find an equivalent NFA from the given NFA- ϵ. Use this algorithm to draw an NFA for the NFA- ϵ given below. 	**4**
d	For the DFA shown below, use the minimization algorithm to find a minimum state DFA recognizing the same language. 	**4**
3 a	State and prove pumping lemma for regular languages. Use pumping lemma to show that the following languages are not regular. a) $L=\{ww \mid w \in \{0,1\}^*\}$. b) $L=\{xy \mid x,y \in \{0,1\}^*$ and y is either x or $x^r\}$.	**6**
b	Describe decision algorithm to answer the following questions. a) Given two DFA's M1 and M2, are there any strings that are accepted by neither. b) Given a regular expression r and an DFA M, are the corresponding languages are same?	**4**

c	Let M1, M2 and M3 are the DFA's pictured below recognizing languages L1, L2 and L3 respectively.  Draw DFA's recognizing the following languages. a) L1 U L2 b) L1 L2 c) L1-L2	**6**
	OR	
4 a	Define CFG, Language generated by CFG, Left most derivation and Right most derivation. Consider the grammar below S→S+S | S-S | S*S | S/S | (S) | a. i. Give two left most derivations for the string a+(a*a)/a-a. ii. Give the derivation tree corresponds to each of the derivations in (i). iii. How many distinct left most derivations of this string are there? **iv.** How many derivation trees are there for the string a+a+a+a+a?	**4**
b	In each case, given the context free grammar G, find an equivalent CFG with no useless variables. i. S→ABC | BaB, A→aA | BaC | aaa, B→bBb | a, C→CA | AC ii. S→AB | AC, A→aAb | bAa | a | ϵ, B→bbA | aaB | AB, C→abCa | aDb | ϵ, D→bD | aC	**4**
c	Define GNF grammar. Given below a CFG G, find a CFG G^1 in GNF generating L(G) – { ϵ }. A→BC, B→CA | b, C→AB | a	**4**
d	Draw the NFA accepting the language generated by the grammar with productions S→abA|bB|aba, A→b|aB|bA, B→aB|aA	**4**
5 a	Define PDA. Construct PDA for L={ww^R | w ϵ {a,b}*}. Show by IDs the string abaaba is accepted.	**6**
b	Let L be L(M1) for some PDA with empty stack M1=(Q,∑,Γ,δ,q_0,Z_0,ϕ), prove that there exists an final state PDA M2 such that L=L(M2). Construct empty stack PDA to accept L={w | w ϵ {a,b}* and w is palindrome}. Convert it into equivalent final state PDA.	**4**
c	What are steps to be followed while finding an equivalent PDA by empty stack for the given CFG. Find the equivalent PDA to the CFG with productions S→aSb | bSa | abS | baS | Sab | Sba | ϵ. Show that the string abaabb is generated by the given CFG and it is accepted by its equivalent PDA.	**6**
	OR	

6 a	State and prove pumping lemma for context free languages. Show that L={ww | w $\in$ {a,b}*} is not context free.	**6**
b	Let L1={$a^i b^j c^k$ | i< j } and L2={ $a^i b^j c^k$ | i< k }. Show that L1 and L2 are context free but L3=L1$\cap$ L2 is not context free.	**6**
c	Decide whether the following languages are CFL or not. i. L={$a^n b^m a^m b^n$| m,n≥0}. ii. L={xayb| x,yϵ{a,b}* and |x|=|y|}.	**4**
7 a	Design Turing Machine to accept the language L={ w | ε {a, b}* and Na(w)=Nb(w)}. Trace the machine for the string *baabab*.	**6**
b	Let x and y are two positive integers represented using unary notation. Design a Turing Machine that computes the function f(x,y), where x,y ϵ 1^+ f(x, y) = x - y if x > y f(x, y) = y - x if y>x f (x, y)=0 if x = y	**6**
c	If L_1 and L_2 are recursively enumerable languages over ∑, then show that L_1 U L_2 is also recursively enumerable languages.	**4**
	OR	
8 a	Design Turing Machine to perform the string reverse operation over ∑={a, b, c}. Use Instantaneous Descriptions to show operation on w=*abac*.	**8**
b	Write a note on i. Multi tape Turing Machine ii. Non deterministic Turing Machine	**6**
c	Prove that every regular language is also a recursively enumerable language.	**2**
9 a	Construct the Linear Bounded Automata for the language L={ ww^R | w ε {a, b}*}. Trace the machine for the string *aabbaa*.	**8**
b	Define Context Sensitive Grammar. Give Context Sensitive Grammar to generate the language L={ $a^n b^n c^n d^n$ | n ≥1}. Show that the string *aabbccdd* is generated by the grammar.	**4**
c	Write a note on Chomsky hierarchy.	**4**
	OR	
10 a	Define Unrestricted Grammar. Give Unrestricted Grammar to generate the language L={ w | ε {a, b, c}* and Na(w)=Nb(w)=Nc(W)}.Show that the string *acabcb* is generated by the grammar.	**8**
b	Write a note on undecidability.	**4**
c	If the given language L is Context Sensitive Language, then L is recursively enumerable language. Prove this statement.	**4**

Q.P.Code
Course code: 21CS54 **Course Title: Theory of Computation**

PART-A

Q.No	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
BT	1	2	3	1	2	3	2	1	1	2
COs	1	1	2	1	2	2	2	1	2	1
Q.No	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
BT	3	4	4	4	1	3	3	2	1	4
COs	2	3	3	2	1	3	2	1	2	3

PART-B

Question No		BT level	COs Addressed		Question No		BT level	COs Addressed
2	a	2	1		3	a	3	2
	b	3	2			b	2	2
	c	4	3			c	4	3
	d	4	3			d		
4	a	3	3		5	a	3	3
	b	4	3			b	2	2
	c	4	4			c	2	3
	d	3	4			d		
6	a	2	2		7	a	4	4
	b	3	3			b	4	4
	c	3	4			c	3	2
	d					d		
8	a	4	4		9	a	4	4
	b	3	2			b	3	2
	c	3	2			c	1	1
	d	4	1			d		
10	a	3	3			a		
	b	2	1			b		
	c	2	1			c		
	d					d		

Signature of Scrutinizer **Signature of Chairman**

Name: **Name:**