

R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU)

V Semester B.E

Model Question paper

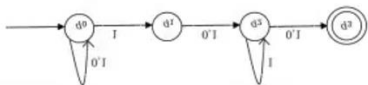
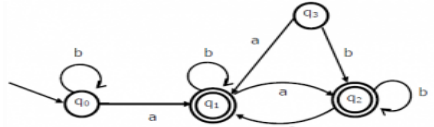

THEORY OF COMPUTATION

Time: 03 Hours

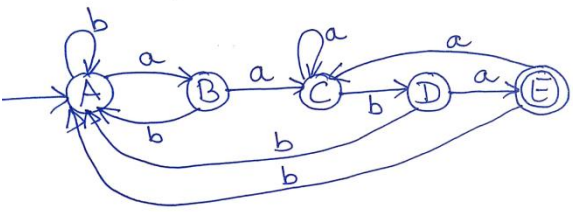
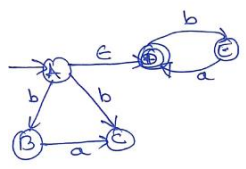
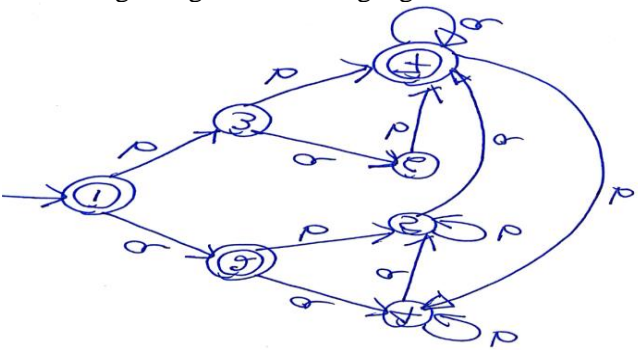
Maximum Marks: 100

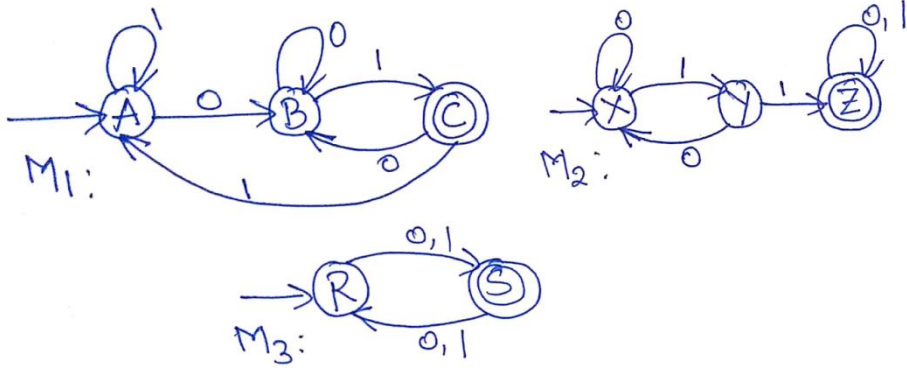
Instructions to Candidate:

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	<p>Consider the following automata. What is the set of reachable states for the input string 0011?</p> 	1
1.2	<p>The minimum state automaton equivalent to the below FA has how many number of states</p> 	1
1.3	<p>Find $R^2_{12} = ?$</p> 	1
1.4	<p>Define ϵ-closure (q), where $q \in Q$ of an automata.</p>	1
1.5	<p>In each case, find a string of minimum length in $\Sigma^* = \{0, 1\}^*$ not in the language corresponding to the given regular expression.</p> <ol style="list-style-type: none"> i. $(0^* + 1^*)(0^* + 1^*)(0^* + 1^*)$ ii. $0^*(100^*)^*1^*$ 	1

1.6	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?	1																		
1.7	Give CFG for the language "The set of odd length strings in $\{a, b\}^*$ with the middle symbol a".	1																		
1.8	Show that the grammar with indicated productions is ambiguous. $S \rightarrow aSb \mid aaSb \mid \epsilon$	1																		
1.9	Define Left Most Derivation (LMD). Give LMD for abaaba in the grammar with productions $S \rightarrow aSaSbS \mid aSbSaS \mid bSaSaS \mid \epsilon$	1																		
1.10	Identify the nullable variables in the grammar given below. $S \rightarrow AB \mid ABC, A \rightarrow BA \mid BC \mid a \mid \epsilon, B \rightarrow AC \mid CB \mid b \mid \epsilon, C \rightarrow AB \mid BC \mid c$	1																		
1.11	If G is a context free grammar in CNF and $x \in L(G)$ with $ x =n$. How many steps are there in the derivation of x in G?	1																		
1.12	Let G be the CFG with productions $S \rightarrow S+S \mid S-S \mid S*S \mid S/S \mid (S) \mid a$ How many derivation strings are there for the string $a+(a*a)/a-a$?	1																		
1.13	DFA whose transition table is as below, here state A is the start state and states B, C are final states. <table border="1" data-bbox="289 835 467 1024"> <tr> <th>δ</th><th>a</th><th>b</th></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> <p>What is the equivalent left linear grammar for the above DFA.</p>	δ	a	b	A	B	B	B	C	C	C	D	D	D	A	B	1			
δ	a	b																		
A	B	B																		
B	C	C																		
C	D	D																		
D	A	B																		
1.14	Consider the right linear grammar with the productions $A \rightarrow aB \mid bD, B \rightarrow aB \mid bC \mid \epsilon, C \rightarrow aB \mid bC \mid \epsilon, D \rightarrow aD \mid bD$ Find the left linear grammar which is equivalent to the above right linear grammar.	1																		
1.15	Define Deterministic Push Down Automata.	1																		
1.16	What is the language generated by the Context Sensitive Grammar with the productions $S \rightarrow ABCS \mid ABC, AB \rightarrow BA, AC \rightarrow CA, BC \rightarrow CB, BA \rightarrow AB, CA \rightarrow AC, CB \rightarrow BC, A \rightarrow a, B \rightarrow b, C \rightarrow c$.	1																		
1.17	Obtain Turing Machine to accepts the language $L = \{w \mid w \in \{a, b\}^* \text{ and } w \text{ ends with } abb\}$.	1																		
1.18	What is the language generated by the right linear grammar with productions $S \rightarrow aA \mid bC \mid b, B \rightarrow aC \mid bA \mid a, A \rightarrow aS \mid bB, C \rightarrow aB \mid bS$.	1																		
1.19	If L1 and L2 are recursively enumerable languages, then $L1 \cap L2$ is recursively enumerable language. Is this statement is TRUE or FALE.	1																		
1.20	What is the solution to the instance of PCP given below. <table border="1" data-bbox="289 1617 784 1843"> <tr> <th></th><th>List A</th><th>List B</th></tr> <tr> <th></th><th>X_i</th><th>Y_i</th></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>		List A	List B		X_i	Y_i	1	1	010	2	0	10	3	10	101	4	01	100	1
	List A	List B																		
	X_i	Y_i																		
1	1	010																		
2	0	10																		
3	10	101																		
4	01	100																		

	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) $L = \{xy \mid x, y \in \{0,1\}^* \text{ and } y \text{ is either } x \text{ or } x^r\}$.	6
b	Describe decision algorithm to answer the following questions. a) Given two DFA's M_1 and M_2 , 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	<p>Let M_1, M_2 and M_3 are the DFA's pictured below recognizing languages L_1, L_2 and L_3 respectively.</p>  <p>Draw DFA's recognizing the following languages.</p> <ol style="list-style-type: none"> $L_1 \cup L_2$ $L_1 \cap L_2$ $L_1 - L_2$ 	6
OR		
4 a	<p>Define CFG, Language generated by CFG, Left most derivation and Right most derivation. Consider the grammar below $S \rightarrow S+S \mid S-S \mid S*S \mid S/S \mid (S) \mid a$.</p> <ol style="list-style-type: none"> Give two left most derivations for the string $a+(a*a)/a-a$. Give the derivation tree corresponds to each of the derivations in (i). How many distinct left most derivations of this string are there? How many derivation trees are there for the string $a+a+a+a+a$? 	4
b	<p>In each case, given the context free grammar G, find an equivalent CFG with no useless variables.</p> <ol style="list-style-type: none"> $S \rightarrow ABC \mid BaB, A \rightarrow aA \mid BaC \mid aaa, B \rightarrow bBb \mid a, C \rightarrow CA \mid AC$ $S \rightarrow AB \mid AC, A \rightarrow aAb \mid bAa \mid a \mid \epsilon, B \rightarrow bbA \mid aaB \mid AB, C \rightarrow abCa \mid aDb \mid \epsilon, D \rightarrow bD \mid aC$ 	4
c	<p>Define GNF grammar. Given below a CFG G, find a CFG G^1 in GNF generating $L(G) - \{ \epsilon \}$. $A \rightarrow BC, B \rightarrow CA \mid b, C \rightarrow AB \mid a$</p>	4
d	<p>Draw the NFA accepting the language generated by the grammar with productions $S \rightarrow abA \mid bB \mid aba, A \rightarrow b \mid aB \mid bA, B \rightarrow aB \mid aA$</p>	4
5 a	<p>Define PDA. Construct PDA for $L = \{ ww^R \mid w \in \{a,b\}^* \}$. Show by IDs the string abaaba is accepted.</p>	6
b	<p>Let L be $L(M_1)$ for some PDA with empty stack $M_1 = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, \phi)$, prove that there exists an final state PDA M_2 such that $L = L(M_2)$. Construct empty stack PDA to accept $L = \{ w \mid w \in \{a,b\}^* \text{ and } w \text{ is palindrome} \}$. Convert it into equivalent final state PDA.</p>	4
c	<p>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 $S \rightarrow aSb \mid bSa \mid abS \mid baS \mid Sab \mid Sba \mid \epsilon$. Show that the string abaabb is generated by the given CFG and it is accepted by its equivalent PDA.</p>	6

	OR	
6 a	State and prove pumping lemma for context free languages. Show that $L=\{ww \mid w \in \{a,b\}^*\}$ is not context free.	6
b	Let $L_1=\{a^i b^j c^k \mid i < j\}$ and $L_2=\{a^i b^j c^k \mid i < k\}$. Show that L_1 and L_2 are context free but $L_3=L_1 \cap L_2$ is not context free.	6
c	Decide whether the following languages are CFL or not. i. $L=\{a^n b^m a^m b^n \mid m,n \geq 0\}$. ii. $L=\{xayb \mid x,y \in \{a,b\}^* \text{ and } x = y \}$.	4
7 a	Design Turing Machine to accept the language $L=\{w \mid w \in \{a,b\}^* \text{ and } N_a(w)=N_b(w)\}$. Trace the machine for the string <i>baabab</i> .	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 $x,y \in 1^+$ $f(x,y) = x - y \quad \text{if } x > y$ $f(x,y) = y - x \quad \text{if } y > x$ $f(x,y) = 0 \quad \text{if } x = y$	6
c	If L_1 and L_2 are recursively enumerable languages over Σ , then show that $L_1 \cup L_2$ is also recursively enumerable languages.	4
	OR	
8 a	Design Turing Machine to perform the string reverse operation over $\Sigma=\{a,b,c\}$. 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 $L=\{ww^R \mid w \in \{a,b\}^*\}$. Trace the machine for the string <i>aabbaa</i> .	8
b	Define Context Sensitive Grammar. Give Context Sensitive Grammar to generate the language $L=\{a^n b^n c^n d^n \mid n \geq 1\}$. Show that the string <i>aabbccdd</i> 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 $L=\{w \mid w \in \{a,b,c\}^* \text{ and } N_a(w)=N_b(w)=N_c(w)\}$. Show that the string <i>acabcb</i> 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

Name:

Signature of Chairman

Name: