USN

RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

IV Semester B. E. Fast Track Examinations Oct-2020

Computer Science and Engineering

THEORY OF COMPUTATION

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

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

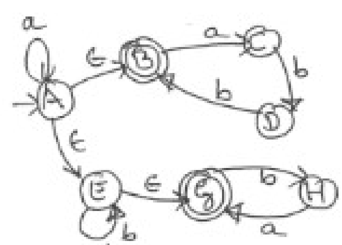
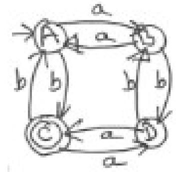
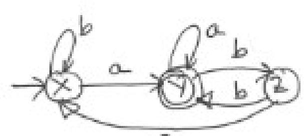
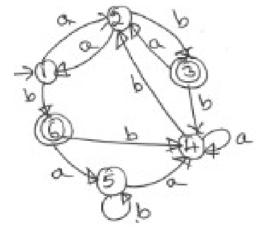
PART-A

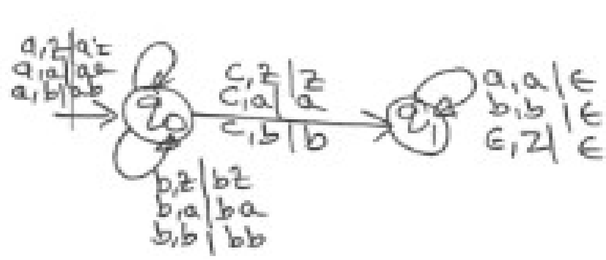
<table>
<tr><td>1</td><td>1.1</td><td>Find a string of minimum length in $\{0,1\}^*$ not in the language corresponding to the regular expression $0^*(100^*)^*1^*$</td><td>01</td></tr>
<tr><td></td><td>1.2</td><td>Consider the two regular expressions
r=$0^* + 1^*$ and $s = 01^* + 10^* + 1^*0 + (0^*1)^*$
Find a string corresponds to s but not in r</td><td>01</td></tr>
<tr><td></td><td>1.3</td><td>An NFA with states 1 to 5 and input alphabet $\{a, b\}$ has the following transition table.
<table>
<tr><th>q</th><th>δ (q,a)</th><th>δ(q,b)</th></tr>
<tr><td>→1</td><td>{1,2}</td><td>{1}</td></tr>
<tr><td>2</td><td>{3}</td><td>{3}</td></tr>
<tr><td>3</td><td>{4}</td><td>{4}</td></tr>
<tr><td>4</td><td>{4}</td><td>{∅}</td></tr>
<tr><td>5</td><td>Φ</td><td>{5}</td></tr>
</table>
Draw the transition diagram and calculate $\delta^*(1, abaab)$</td><td>02</td></tr>
<tr><td></td><td>1.4</td><td>Let $M = (Q, \Sigma, \delta,\ q_0.F)$ be an NFA. Show that for any $q \in Q$ and a Σ, $\delta^*(q, a) = \delta(q, a)$</td><td>01</td></tr>
<tr><td></td><td>1.5</td><td>Suppose M is an NFA-$\in$ accepting $\subseteq \Sigma^*$. Describe how to modify M to obtain an NFA-$\in$ recognizing rev(L) = $\{x^r|x\}\in$L}</td><td>01</td></tr>
<tr><td></td><td>1.6</td><td>Consider two NFA-$\in$ below. Decide whether the two NFA-$\in$ accept the same language and give reasons for your answer.

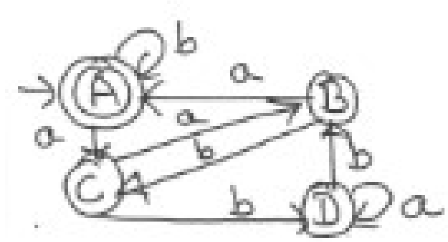
</td><td>01</td></tr>
<tr><td></td><td>1.7</td><td>Describe the decision algorithm to answer the following equation "Given a regular expression γ and $DFA\,M$, are the corresponding language are same?"</td><td>01</td></tr>
<tr><td></td><td>1.8</td><td>Consider the CFG with productions
$S \to aSbScS|aScSbS|bSaScS|bScSaS|cSbSaS|\in$.
Does this grammar generates the language.
$L = \{x | x \in \{a, b, c\}^*\ \&\ n_a(x) = n_b(x) = n_{c(x)}\}$. Justify your answer.</td><td>02</td></tr>
<tr><td></td><td>1.9</td><td>Show that CFG with productions $S \to a|Sa|bSS|SSb|SbS$ is ambiguous</td><td>01</td></tr>
</table>

1.10	In the CFG below, identify the null productions and the unit productions. $S \to ABCBCDA, A \to CD, B \to Cb, C \to a \mid \in, D \to bD \mid \in$.	01
1.11	Show that if L is accepted by a PDA in which no symbols are ever removed from the stack then L is regular	01
1.12	If L is CFL then there exists a $DPDA$ which accepts L. is this statement true or false. Justify your answer.	01
1.13	Describe the language generated by the regular grammar with productions $S \to aA \mid bC \mid b, A \to aS \mid bB, B \to aC \backslash bA \mid a, C \to aB \mid bS$.	01
1.14	Given below a DFA accepting the language L, find a regular grammar generating $L - \{\in\}$. 	01
1.15	Give the unrestricted grammar to generate the language L over $\Sigma = \{a, b, c\}$, where $L = \{w \mid n_a(w) = n_b(w) = n_c(w)\}$.	02
1.16	Give the transition diagram of a turing machine that accepts $L = \{w \mid w \in \{a, b\}^* \,\&\, w \in \{a, b\}^* aba$.	02

PART-B

2	a	Find the equivalent DFA to the given NFA-$\in$ whose transition diagram is as follows. 	08
	b	Transition diagrams for two $DFA's$ $M1$ and $M2$ are shown below. Draw the DFA recognizing each of the following languages. i) $L1 \cup L2$ ii) $L1 - L2$  M1  M2	04
	c	Find a minimum state DFA for the below DFA 	04

3	a	State and prove pumping lemma for regular languages. Apply this lemma to show that $L = \{0^n \mid n \text{ is prime}\}$ is not regular	08
	b	Find the CFG to generate each of the following languages: i) $L = \{a^i b^j c^k \mid i = j + k\}$ ii) $L = \{a^i b^j c^k \mid i = j or\ j = k\}$	04
	c	Simplify the below CFG with productions $S \rightarrow ABCBCDA, A \rightarrow CD, B \rightarrow Cb, C \rightarrow a \mid \in, D \rightarrow bD \mid \in$	04
		OR	
4	a	Find the language generated by the below grammar $S \rightarrow SS \mid bTT \mid TbT \mid TTb \mid \in$ $T \rightarrow aS \mid SaS \mid Sa \mid a$	04
	b	Show that the CFG with productions $S \rightarrow S(S) \mid \in$ is unambiguous.	04
	c	For the CFG , G given below, find a CFG, $G^{\vert}$ in GNF generating $L(G) - \{\in\}$. $S \rightarrow AaA \mid cA \mid BaB, A \rightarrow aaBa \mid CDA \mid aa \mid DC, B \rightarrow bB \mid bAB \mid bb \mid aS, C \rightarrow Ca \mid bC \mid D, D \rightarrow bD \mid \in.$	08
5	a	Let L be $L(M1)$ for some PDA with final state, $M1 = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$, prove that there exists an empty stack PDA, $M2$ such that $L(M1) = L(M2)$. Construct final state PDA to accept $L = \{a^i b^j c^k \mid i = j or\ j = k\}$. Convert it into equivalent empty stack PDA.	09
	b	Define $DPDA$. Construct $DPDA$ to accept the language $L = \{x \mid x \in \{a, b\}^* \ \&n_a(x) > n_b(x)\}$. Illustrate the operation of this machine on the input string abbabaa	07
		OR	
6	a	How to find an equivalent CFG from a given PDA. Find the equivalent CFG to the PDA whose transition diagram is shown below. Show that the string $abacaba$ is accepted by the PDA and it is generated by the equivalent CFG. 	08
	b	Apply pumping lemma for CFL to show that the language $L = \{a^i b^j c^k \mid i < j < k$ is not context free.	03
	c	Consider two languages over $\Sigma = \{a, b, c\}. L1 = \{a^i b^j c^k \mid i < j$ and $L2 = \{a^i b^j c^k \mid i < k$. Show that $L1$ and $L2$ are context free language but $L1 \cap L2$ and L1 are not context free.	05

7	a	Construct LBA to accept the language $L = \{ww \mid w \in \{a, b\}^*$ .Show that the string abbabb is accepted	08
	b	Find the equivalent left linear grammar to the language accepted by the following DFA. 	05
	c	Show that all regular grammars are linear but every linear grammars need not be regular.	03
8	a	Construct a turing machine to accept the language $L = \{w \mid w \in \{a, b\}^* \,\&\, n_a(\mathrm{w}) = n_b(w)$. Trace the machine for the string $abbbabaa$.	08
	b	Find the unrestricted grammar to generate the language $L = \{w \mid w \in \{a, b\}^*$. Show the derivation for the string $baabaa$.	04
	c	If $L1$ and $L2$ are recursively enumerable language over Σ then $L1 \cup L2$ and $L1 \cap L2$ are also recursively enumerable.	04