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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Examination December 2021 (2019 scheme)

Course Code: CST301

Course Name: FORMAL LANGUAGES AND AUTOMATA THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

1	Draw the state transition diagram showing a DFA for recognizing the language L over the alphabet set $\Sigma = \{a, b\}$: $L = \{x \mid x \in \Sigma^*$ and the number of a in x is divisible by 2 or 3$\}$.	3
2	Write a Regular Grammar G for the language: $L = \{0^n 1^m : n, m >= 1\}$	3
3	Construct an ε-NFA for the regular expression $(a+b)^*ab(a+b)^*$	3
4	Using homomorphism on Regular Languages, Prove that the language $L=\{a^n b^n c^{2n} \mid n>=0\}$ is not regular. Given that the language $\{a^n b^n : n >= 1\}$ is not regular.	3
5	State Myhill-Nerode Theorem.	3
6	Write a Context-Free Grammar for the language $L = \{wcw^r \mid w \in \{a,b\}^* \}$, w^r represents the reverse of w.	3
7	Write the transition functions of PDA with acceptance by Final State for the language $L = \{a^n b^n : n >= 0\}$.	3
8	State Pumping Lemma for Context Free Languages.	3
9	Write the formal definition of Context Sensitive Grammar and write the CSG for the language $L = \{ a^n b^n c^n \mid n>=1 \}$.	3
10	Explain Chomsky hierarchy of languages.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11	a)	Draw the state-transition diagram showing a DFA for recognizing the language: $L = \{x \in \{a,b\}^* \mid$ every block of five consecutive symbols in x contains two consecutive a's.$\}$	6

b) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFA D equivalent to N by applying the subset construction algorithm. L = {x ∈ {a, b} * | x contains ‘bab’ as a substring} 8

12 a) Define Regular Grammar and write Regular Grammar G for the following language : L = {x ∈ {a, b} * | x does not ends with ‘bb’ } 7

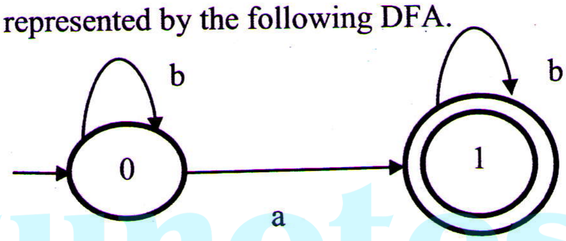
b) Obtain the DFA over the alphabet set Σ = {a, b}, equivalent to the regular grammar G with start symbol S and productions: S → aA | bS , A → aB | bS | a *and* 7

B → aB | bS | a

Module -2

13 a) State and explain any three closure properties of Regular Languages. 6

b) Find the equivalent Regular Expression using Kleene’s construction for the language represented by the following DFA. 8



14 a) Using pumping lemma for Regular Languages, prove that the language $L = \{0^n \mid n \text{ is a perfect square}\}$ is not Regular. 7

b) Obtain the minimum state DFA for the following DFA. 7

	a	b
→0	1	2
1	4	5
2	0	3
3	5	2
4	1	0
5	4	3

Module -3

15 a) Show the equivalence classes of Canonical Myhill-Nerode relation for the language of binary string which starts with 1 and ends with 0. 7

b) Consider the following productions: 7

S → aB | bA

A → aS | bAA | a

$B \rightarrow bS \mid aBB \mid b$

For the string 'baaabbba' find

i) The leftmost derivation

ii) The rightmost derivation

iii) The parse tree

16 a) Construct the Grammars in Chomsky Normal Form generating the set of all strings over {a,b} consisting of equal number of a's and b's. 7

b) Find the Greibach Normal Form for the following Context Free Grammar $S \rightarrow XA \mid BB$, $B \rightarrow b \mid SB$, $X \rightarrow b$, $A \rightarrow a$ 7

Module -4

17 a) Design a PDA for the language $L = \{ww^r \mid w \in \{a,b\}^* \}$. Also illustrate the computation of the PDA on the string 'aabbaa'. 7

b) Construct a CFG to generate L(M) where $M = (\{p, q\}, \{0, 1\}, \{X, Z_0\}, \delta, q, Z_0, \emptyset \}$ where δ is defined as follows: 7

$\delta(q, 0, Z_0) = (q, XZ_0)$

$\delta(q, 0, X) = (q, XX)$

$\delta(q, 1, X) = (p, \varepsilon)$

$\delta(p, 1, X) = (p, \varepsilon)$

$\delta(p, \varepsilon, X) = (p, \varepsilon)$

$\delta(p, \varepsilon, Z_0) = (p, \varepsilon)$

18 a) Using pumping lemma for Context free languages, prove that the language $L = \{ a^n b^n c^n \mid n>=1 \}$. 7

b) Prove that CFLs are closed under Union, Concatenation and Homomorphism. 7

Module -5

19 a) Design Linear Bounded Automata for the language $L = \{ a^n b^n c^n \mid n>=1 \}$. 7

b) Design a Turing Machine for the language $L = \{ a^n b^{2n} \mid n>=1 \}$. Illustrate the computation of TM on the input 'aaabbbbbb'. 7

20 a) Design a Turing Machine to obtain the product of two natural numbers a and b both represented in unary on the alphabet 0. For example, number 5 is represented as 00000 ie 0^5. Assume that initially the input tape contains 0^a10^b and Turing machine should halt with 0^{a*b} as the tape content. 7

b) Prove that 'Turing Machine halting problem' is undecidable. 7

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