29·5·2023 (M)

SOMAIYA
VIDYAVIHAR UNIVERSITY

Semester: January 2023 –May 2023			
Maximum Marks: 100	**Examination: ESE Examination**		**Duration:3 Hrs.**
Programme code: 01 **Programme: B Tech in Computer Engineering**		**Class: SY**	**Semester: IV(SVU 2020)**
Name of the Constituent College: **K. J. Somaiya College of Engineering**		**Name of the department: COMP**	
Course Code: 116U01C404	**Name of the Course: Theory of Automata with Compiler Design**		
Instructions: 1)Draw neat diagrams 2) All questions are compulsory **3) Assume suitable data wherever necessary**			

Que. No.	Question	Max. Marks
Q1	Solve any **Four**	20
i)	Minimize the following FA with: <table><tr><td></td><td>0</td><td>1</td></tr><tr><td>→A</td><td>B</td><td>D</td></tr><tr><td>B*</td><td>A</td><td>C</td></tr><tr><td>C</td><td>B</td><td>D</td></tr><tr><td>D*</td><td>C</td><td>A</td></tr></table>Show step wise solution	5
ii)	What are some real-world applications of DFA and NFA in programming languages, compilers, and natural language processing?	5
iii)	Design a DFA that recognizes the language of all strings over {0, 1} that have an equal number of 0s and 1s.(State machine and table is expected, No simulation)	5
iv)	Design a NFA that recognizes the language of all strings over {a,b} that have 'bab' as a suffix.	5
v)	Write a regular expression for the language $L = \{w \in \{a, b\}^* \mid w$ contains the substring ab} with explanation.	5
vi)	Explain how the product of FA can be used to solve the problem of language inclusion.	5

Que. No.	Question	Max. Marks
Q2 A	Solve the following	10
i)	Given the grammar $S \rightarrow A$, $A \rightarrow AB \mid a$, $B \rightarrow bB \mid \varepsilon$, show derivation steps and construct a derivation tree for the string aaabbbb.	5
ii)	Use Arden's theorem to find a regular expression for the language $L = \{w \in \{a, b\}^* \mid w$ contains at least three consecutive b's}.	5

	or	
Q2 A	How does the Chomsky hierarchy relate to the concepts of decidability and undecidability in formal language theory? Explain with suitable example.	10

Q 2 B	Solve any **One**	**10**
i)	Design a DFA to recognize the language of all strings over the alphabet {a,b} that have a length of at least 3 and end with the same symbol as their first symbol.	10
ii)	Design an NFA that recognizes the language of all strings over {a, b} that contain an odd number of occurrences of the substring aba or the substring bab.	10

Que. No.	Question	dMax. Marks
Q3	Solve any **Two**	**20**
i)	Design a Turing machine that accepts the language of all strings over the alphabet {0, 1} that represents binary numbers that are divisible by 3.	10
ii)	Design Turing machine to copy a string(Consider the single tape).	10
iii)	Design a Turing machine that accepts the language of all strings over the alphabet {a, b} that have an odd number of b's.	10

Que. No.	Question	Max. Marks
Q4	Solve any **Two**	**20**
i)	Construct a PDA for the CFG $G = (V, \Sigma, R, S)$ where $V = \{S, A, B\}$, $\Sigma = \{a, b\}$, $R = \{S \rightarrow A, A \rightarrow aA, A \rightarrow bB, B \rightarrow bB, B \rightarrow \varepsilon\}$.	10
ii)	Convert the PDA ({q0, q1, q2, q3}, {0, 1}, {Z0}, δ, q0, {Z0}) with the following transition function: $\delta(q0, \lambda, Z0) = \{(q1, Z0)\}$ $\delta(q1, 0, Z0) = \{(q1, 0Z0)\}$ $\delta(q1, 1, Z0) = \{(q2, \lambda)\}$ $\delta(q2, 1, Z0) = \{(q2, \lambda)\}$ $\delta(q2, \lambda, Z0) = \{(q3, Z0)\}$ $\delta(q3, 0, 0) = \{(q3, \lambda)\}$ $\delta(q3, 1, 0) = \{(q3, \lambda)\}$ $\delta(q3, \lambda, Z0) = \{(q0, \lambda)\}$ to a CFG and simplify the resulting grammar.	10
iii)	Design a PDA for the language L = {w#w^R | w ∈ {a, b}*}, where # is a special symbol not in the alphabet and w^R denotes the reverse of w.	10

Que. No.	Question	Max. Marks
Q5	(Write notes / Short question type) on any **four**	**20**
i)	Show that the language of all valid parentheses expressions is a context-free language, but not a regular language.	5
ii)	Can every context-sensitive language be recognized by a linear bound automaton? Why or why not?	5
iii)	How does a PDA differ from a finite state automaton (FSA) and a Turing machine (TM)?	5
iv)	What are some real-world applications of Rice's Theorem?	5
v)	Can a problem that can be solved by a single-tape Turing machine also be solved by a multitape Turing machine? Justify.	5
vi)	What are some challenges associated with applying the pumping lemma for context-free languages in practice?	5