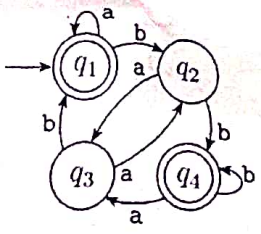
COLLEGE OF ENGINEERING, PUNE
(An Autonomous Institute of Government of Maharashtra.)

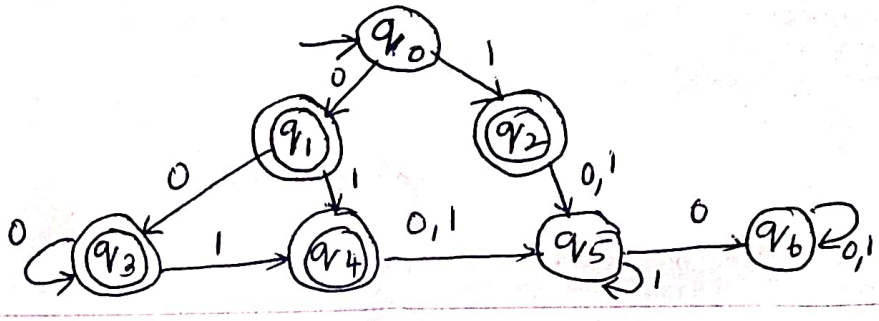
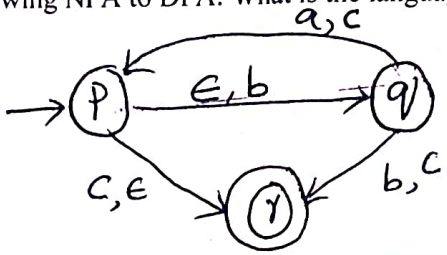
END Semester Examination

Programme: B.Tech
Course Code: ~~CS401~~ CT – 20012
Branch: Computer Engineering
Duration: 3 hours
Student PRN No.

Semester: IV
Course Name: Theory of Computation
Academic Year: 2021-22
Max Marks: 60

Instructions:
1. Figures to the right indicate the full marks.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper/Hall Ticket is not allowed.
4. Exchange/Sharing of stationery, calculator etc. not allowed.
5. Write your PRN Number on Question Paper.
6. Answer all six complete questions
7. Use separate answer books for Section I and Section II

		Section I	Marks	CO	PO
Q 1	a	Construct a DFA recognizing binary numbers divisible by 5. Show the computation on the string 1111.	4	1	1
	b	Let $\Sigma = \{0, 1\}$ and let $L = \{w \mid w$ contains an equal number of occurrences of the substrings 01 and 10$\}$. Thus $101 \in L$ because 101 contains a single 01 and a single 10, but $1010 \notin L$ because 1010 contains two 10s and one 01. Construct a DFA for L.	3	1	1
	c	Prove that every NFA can be converted into an equivalent one that has a single accept state.	3	2	1
Q 2	a	Find the regular expression for the following languages: i. All strings over {a, b} that contain both aa and bab as substrings ii. Let $\Sigma = \{a, b, /, *\}$. In certain programming languages, comments appear between delimiters such as /* and */. Let L be the language of all valid delimited comment strings.	4	1	1
	b	Convert the regular expression $(((00)^*(11)) + 01)^*$ into NFA	3	2	1
	c	Convert the following automata to a regular expression. 	3	2	1
Q 3	a	Let $\Sigma = \{1, \#\}$ and let $L = \{w \mid w = x_1\#x_2\#\cdots\#x_k$ for $k \geq 0$, each $x_i \in 1^*$, and $x_i != x_j$ for $i != j\}$. Prove that L is not regular.	3	3	1

	b	Find the minimized DFA for the following 	3	2	1
	c	Convert the following NFA to DFA. What is the language accepted by this FA? 	4	2	1

Section II

Q 4	a	Find CFG for the language i) $L = \{a^i b^j \mid i<=2j\}$ ii) $L = \{w \mid n_a(w) = n_b(w) + 1\}$	4	1	1
	b	For the below CFG over {0, 1}*, check whether 11*1+01 is in the language of the CFG. $S \rightarrow S+S \mid S*S \mid N$ $N \rightarrow N0 \mid N1 \mid 0$	2	1	1
	c	Convert the following Context Free Grammar to Chomsky Normal Form. $S \rightarrow ABCd$ $A \rightarrow BC$ $B \rightarrow bB \mid \varepsilon$ $C \rightarrow cC \mid \varepsilon$	4	2	1
Q 5	a	Design a Push Down Automata for $L = \{a^n ww^R b^n \mid w \in \{a, b\}^*$ and $\lvert w\rvert$ is even, $n > 0\}$. Show the instantaneous descriptions for the string aabbab	5	1	1
	b	For a given Push Down Automata(PDA) $M = (\{p, q\}, \{0, 1\}, \{X, Y, Z\}, \delta, p, Z)$, write the S productions of the equivalent CFG and the productions for transition, $\delta(p, 0, Z) = \{(q, XYZ)\}$	3	2	1
	c	If $L_1 = \{a^i b^{2i} c^j \mid i \geq 1, j \geq 1\}$ and $L_2 = \{a^n b^m c^k \mid n, m, k \geq 1\}$, then what type of language is $L_1 \cap L_2$? Justify your answer.	2	3	1

Q 6	a	Design a Turing Machine to accept the language $L = \{a^n b^{2n} \mid n \geq 1\}$. Show the sequence of moves made by the TM for the input aabbbbb	4	1	1
	b	Say true or false: i. If the strings of a language L can be effectively enumerated in lexicographic order, then L is recursive, but not necessarily Context Free ii. A language is Turing-recognizable *if and only if some enumerator enumerates* the strings of this language in lexicographic order iii. While simulating a non-deterministic TM with a 3-tape TM, the 3rd tape tells which is in the lexicographic order the next computation alternative for the nondeterministic TM iv. While simulating a non-deterministic TM with a 3-tape TM, the tree formed of the possible computation paths of the nondeterministic TM has to be examined using depth first algorithm by going through the strings in the lexicographic order v. The language, L = { www | w ∈ {a, b} * } is not CFL, but Recursive vi. Assume that f(n) is defined by : if n==0: return 1 else: return n * f(n-1) Then f(10.5) is undecidable.	3	4	1
	c	Consider the following non-deterministic TM with initial state q_0 and final state q_2. Show the configurations of TM if initial ID is q_0011.	3	1	1

δ	0	1	B
q_0	$\{(q_0, 1, R)\}$	$\{(q_1, 0, R)\}$	$\emptyset$
q_1	$\{(q_1, 0, R), (q_0, 0, L)\}$	$\{(q_1, 1, R), (q_0, 1, L)\}$	$\{(q_2, B, R)\}$
q_2	$\emptyset$	$\emptyset$	$\emptyset$

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