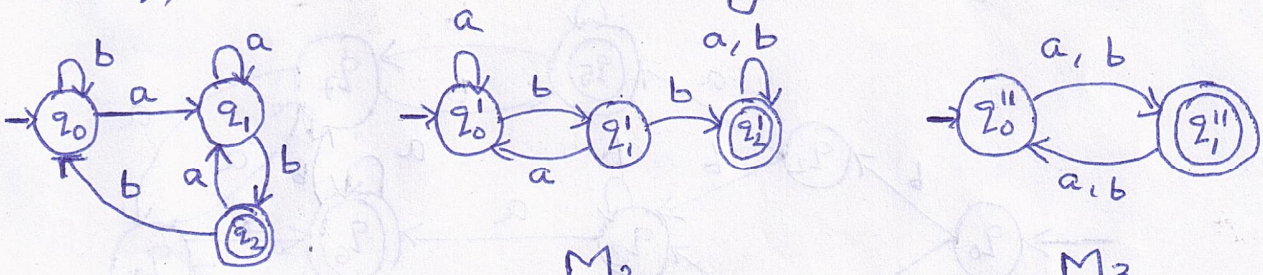
NATIONAL INSTITUTE OF TECHNOLGY PATNA
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
END SEMESTER EXAMINATION, April/May - 2021
B. Tech (Computer Science and Engineering) IVth Semester
CS4402 - Formal Languages & Automata Theory
Max.Marks:40

Note: 1. On top of every page write your roll number, name and page number and subject code

2. Answer all parts of the question at one place only.

1. a) The following M_1, M_2 & M_3 are the three Finite Automatas, recognizing the languages $L(M_1)$, $L(M_2)$, & $L(M_3)$, respectively (Here $\Sigma = \{a, b\}$).



M_1 M_2 M_3

Draw the minimized Deterministic Finite Automatas for any two of the following languages (It is sufficient to show only the transition diagrams).

i) $L(M_1) \cup L(M_2)$.

ii) $L(M_1) \cap L(M_3)$

iii) $L(M_3) - L(M_2)$.

iv) $L_1 = \{ w : (n_a(w) \bmod 3) > (n_b(w) \bmod 3) \}$.

v) $L_2 = \{ w : ((n_a(w) + 2 \cdot n_b(w)) \bmod 3) < 2 \}$.

Note: In iv & v, $w \in (a+b)^*$ & $n_a(w)$, $n_b(w)$ represents the number of a's & number of b's in w, respectively. $-2 \times 4 = 8M$

b) Write the regular expression for the following languages over the alphabet $\Sigma = \{a, b\}$

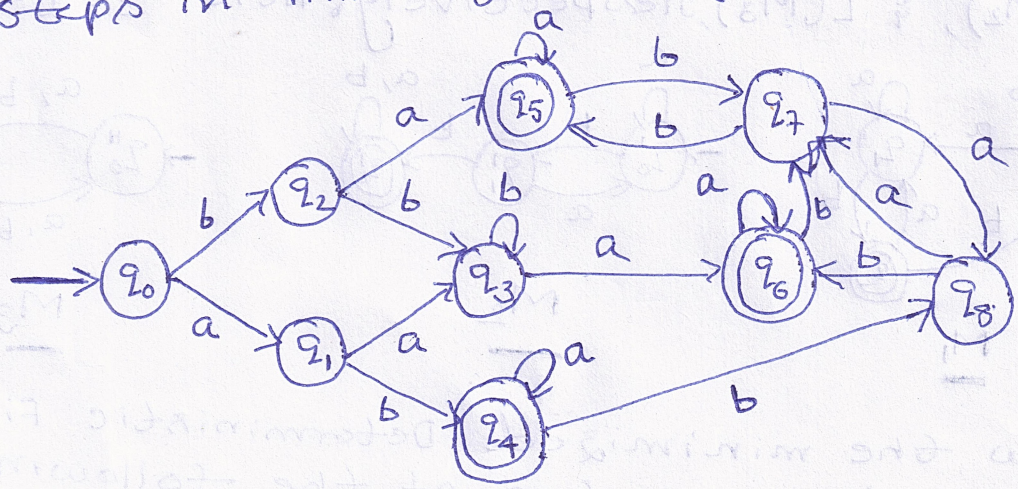
L = { The set of all strings having atmost one pair of consecutive a's & atmost one pair of consecutive b's. } – 2M

P.T.O

2. a) Design Content Free Grammar for the following language over the alphabet $\{a,b\}$. Mention all the tuples of the grammar.

$L = \{ (a+b)^* \mid$ the length of the string is odd & the middle symbol in the string is always the symbol $\underline{a}$. $\}$ – 3M

b) Minimize the following DFA using state equivalence method. Show all the steps in minimization. (Here $\Sigma = \{a,b\}$).



– 5M

c) Using the pumping Lemma show the following language is not regular. (Here $\Sigma = \{a,b\}$).

$L = \{ xy \mid x, y \in (a+b)^*$ & y is either x or $x^R \}$.

(Note: x^R is the reverse of x). – 2M

---

3. a) Construct the Deterministic Push Down Automata for the following language over the alphabet $\{a,b,c\}$. Show all the tuples of PDA.

$L = \{ a^n b^{n+m} c^m \mid m,n \geq 1 \}$. – 4M

b) Prove by example that "The intersection of two content Free languages is not a content Free Language". – 2M P.T.O

c) Consider a Context Free Grammar $G=(V, T, P, S)$, where $V=\{S\}$, $T=\{a,b\}$, $S=S$, & $P=\{S \to SS,\ S \to aSb,\ S \to ab\}$. Convert the G1 into Greibach Normal Form (GNF). – 4M

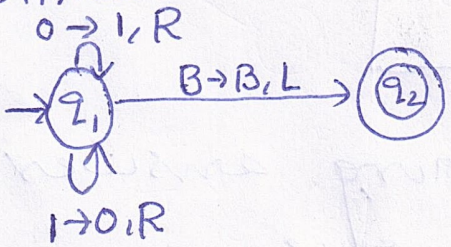
---

4 a) Design a Turing Machine to recognize the following language over the alphabet $\{a,b,c\}$. Mention all the tuples of TM.

$L = \{w \in (a+b+c)^* \mid n_a(w) = n_b(w) = n_c(w)\}$

[Here $n_a(w)$, $n_b(w)$ & $n_c(w)$ are the number of a's, number of b's & number of c's in w] – 6M

b). Consider the following Turing Machine.



Give any two valid Encoding Binary strings for the above Turing Machine. use 0^i to represent i contiguous zeros. – 2M

c). Consider the following languages:

$L_1 = \{a^n b^n c^n \mid n \geq 1\}$.

$L_2 = \{a^P \mid P$ is a prime number$\}$.

L_d (the diagonal language) $= \{w_i \mid w_i$ is not accepted by $M_i\}$

$\bar{L}_1$, $\bar{L}_2$ & $\bar{L}_d$ are the complement languages of L_1, L_2 & L_d respectively.

$L_3 = L_1 \cup L_2$.

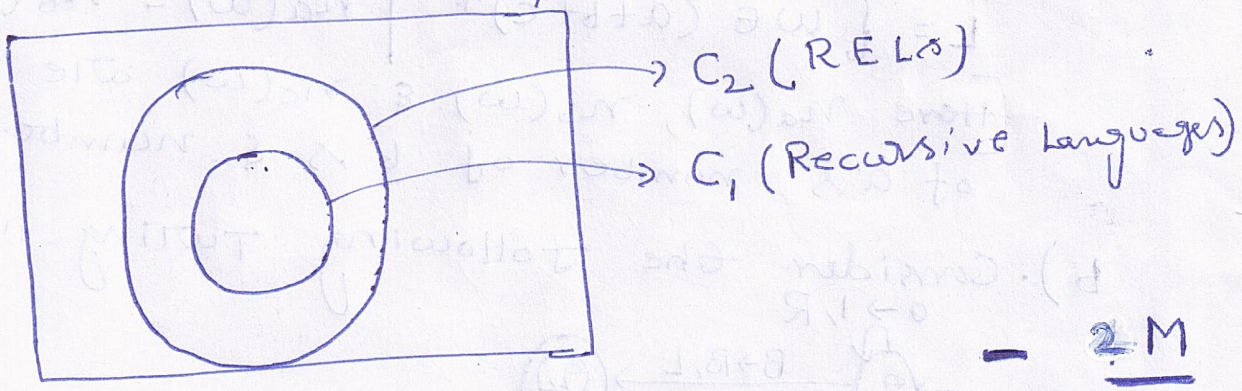
L_4 is a Recursive Enumerable Language &

P.T.O

its complement is also Recursive Enumerable language (L_4 & $\bar{L}_4$ are R.E.Ls)

Mark the above mentioned languages $L_1, L_2, L_3, L_4, L_d, \bar{L}_1, \bar{L}_2$ & $\bar{L}_d$ in one of the areas of the following diagram.

[Each language must belong to a small circle (C_1), Bigger circle (C_2) or Rectangle (R)].



– 2M

Note: Each wrong answer will be deducted 0.5 Marks.

—0—