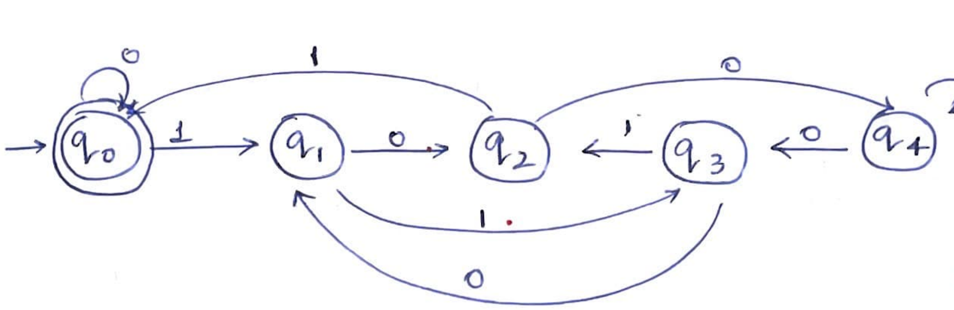
1

Ques 1

a)

	0	1
$\rightarrow q_0^*$	q_0	q_1
q_1	q_2	q_3
q_2	q_4	q_0
q_3	q_1	q_2
q_4	q_3	q_4



2'

3

$0^n 1^m$ $(n+m)$ is even

$$\underbrace{0(00)^*1(11)^*}_{\text{odd + odd}} + \underbrace{(00)^*(11)^*}_{\text{even+even}}$$

2

b). ~~If L is CFL then L is~~

$L - F = L \cap \overline{F}$ $\quad F = \text{Regular} \quad \overline{F} = \text{Regular}$

L → CFL, $\overline{F}$ → RL

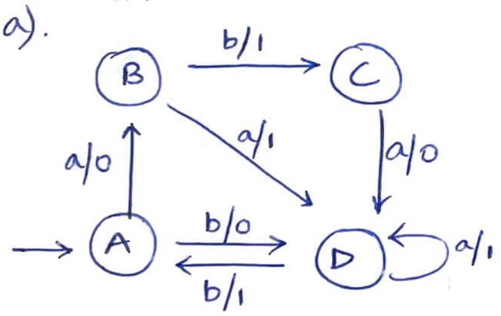
intersection of CFL and RL is CFL.

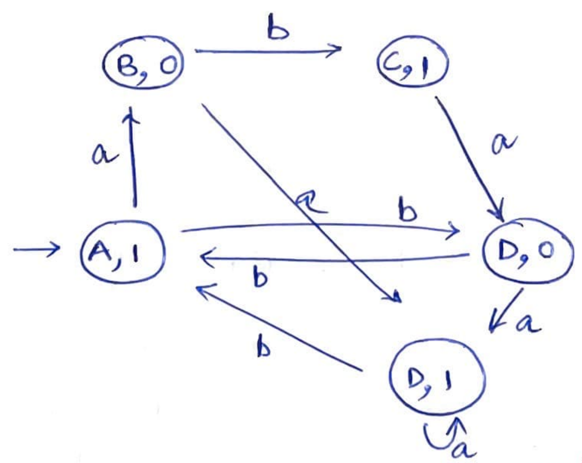
5

Something: 1/2. written something: 2 meaningful. R-L: 2 without explanation. just 1/2. Not adding anything: 5

Ques 2

a).





all transitions not shown: 3/4

5

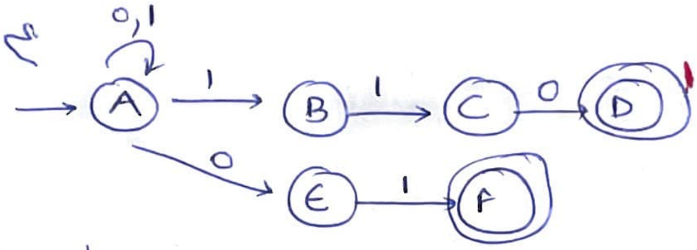
b). Myhill Nerode Theorem:

mentioned minimization: 1/2 not written properly: 1

- Create the pair of all the states involved in the given DFA
- Mark all pairs (Q_a, Q_b) such that Q_a is final state and Q_b is non final state.
- If there is any unmarked pair (Q_a, Q_b) such that $\delta(Q_a, x)$ and $\delta(Q_b, x)$ is marked, then mark (Q_a, Q_b). Here x is input symbol. Repeat this process until no more marking can be made.
- Combine all the unmarked pairs and make them a single state in the minimized DFA.

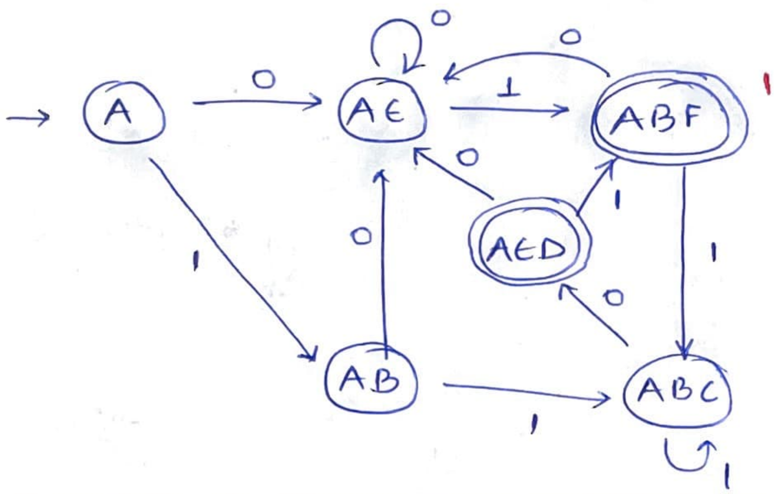
2

NFA :



	0	1
→ A	AE	AB
B	ϕ	C
C	D	ϕ
* D	ϕ	ϕ
E	ϕ	F
* F	ϕ	ϕ

	0	1
→ A	AE	AB
AE	AE	ABF
AB	AE	ABC
* ABF	AE	ABC
ABC	AED	ABC
* AED	AE	ABF



3

Union method : 1

transitions wrong : $2\frac{1}{2}$

Ques 3 :

a). Ardens Theorem: $R = Q + RP \quad R = QP^*$ } 1

✓ $A = Ca + \varepsilon$

✓ $B = Ab + Eb$

$C = Ba + Eb$

$D = Bb$

$E = Da$

✓ $F = Ea + Da$

Replace
$D = Bb$
$E = Bba$

$A = Ca + \varepsilon$

$B = Ab + Bbab$

$C = Ba + Bbab$

$F = Bbaa + Bba$

$$\underset{R}{B} = \underset{Q}{Ab} + \underset{R}{B}\,\underset{P}{bab}$$

$B = (Ab)(bab)^*$

only Eqⁿ & soln : ½
Eqⁿ made mistake
procedure correct : ½
major mistakes A+B+F : ½
Eqⁿ correct, no minimal explanation : 1

$C = Ba + Bbab$

$C = B(a + bab)$

$C = (Ab)(bab)^*(a + bab)$

$$\underset{R}{A} = \underset{R}{A}\underbrace{b(bab)^*(a+bab)a}_{P} + \underset{Q}{\varepsilon}$$

$A = (b(bab)^*(a + bab)a)^*$ ✓

3

$B = Ab\,(bab)^*$

$= (b\,(bab)^*(a+bab)\,a)^*\,b\,(bab)^*$ ✓

4

$f = Bba(a+\varepsilon)$

$= (b\,(bab)^*\,(a+bab)\,a)^*\,b\,(bab)^*\,ba\,(a+\varepsilon)$ ✓

Q3 b).

CNF:	GNF:
$A \to a$	$A \to a$
$A \to BC$	$A \to aBCD..$
$S \to \varepsilon$	$S \to \varepsilon$

1

i). $S \to SS$
$S \to (S)$
$S \to \varepsilon$

$S \to SS|(S)|\varepsilon$

new start symbol
$S' \to S$
$S \to SS|(S)|\varepsilon$

nullable variable:

$S \to \varepsilon$
$S' \to S \to \varepsilon$

$S' \to S|\varepsilon$
$S \to SS|(S)|()$ 1/2

unit productions: $S' \to S \to SS$, $\to (S)$, $\to ()$

$S' \to SS|(S)|()|\varepsilon$ 1/2
$S \to SS|(S)|()$

2

CNF form:

$S' \to SS|AC|AB|\varepsilon$
$S' \to SS|AC|AB$ 1
$A \to ($
$B \to)$
$C \to SB$

missed ε: 1

ii) $S \to AB$
$A \to bA|a$
$B \to aB|\varepsilon$

nullable: B
$S \to AB|A$
$A \to bA|a$ 1/2
$B \to aB|a$

unit: $S \to A \to bA$, $\to a$
$S \to AB|bA|a$
1/2 $A \to bA|a$
$B \to aB|a$

2

GNF form: $S \to bAB|aB|bA|a$
$A \to bA|a$ 1
$B \to aB|a$

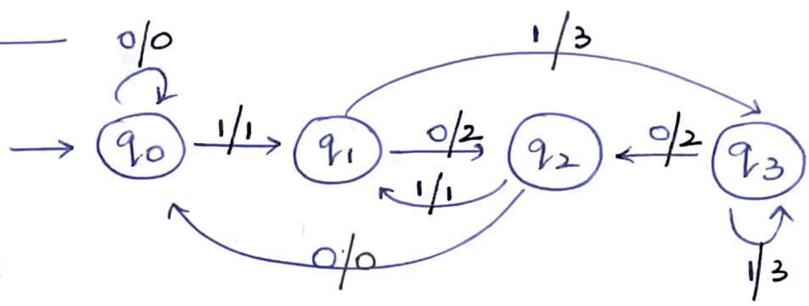
moore made 1.3.

4

Ques 4:

a).

	0	1
q_0	q_0	q_1
q_1	q_2	q_3
q_2	q_0	q_1
q_3	q_2	q_3



5

b). Unrestricted Grammar Type (0)
Context sensitive Grammar (1)
Context free Grammar (2)
Regular Grammar (3)

1

$0^i 1^j 2^k \quad k \le i$

$\overbrace{\underset{A}{\underline{0000}}\ \underset{\substack{B \\ \text{(independent)}}}{\underline{111}}\ \underline{22}}^{S'}$

$S' \to 0S'2 \mid AB$

$A \to 0A \mid \varepsilon$

$B \to 1B \mid \varepsilon$

1/2

$0^i 1^j 2^k \quad k \le j$

$\underset{\substack{A \\ \text{(independent)}}}{\underline{0000}}\ \underset{B}{\underline{11}}\ \overbrace{\underline{111}\ \underline{22}}^{C}$

$S'' \to ABC$

$A \to 0A \mid \varepsilon$

$B \to 1B \mid \varepsilon$

$C \to 1C2 \mid \varepsilon$.

1/2

Combine

$S \to S' \mid S''$

$S' \to 0S'2 \mid AB$

$S'' \to ABC$

$A \to 0A \mid \varepsilon$

$B \to 1B \mid \varepsilon$

$C \to 1C2 \mid \varepsilon$,

1.

4

Ques 5:

a) 'A' is CFL, Pumping length 'P', any string 'S' where $|S| \ge P$ can be divided into 5 pieces $S = uvxyz$ such that

1 uv^ixy^iz is in A for every $i \ge 0$

1 $|vy| > 0$

1 $|vxy| \le P$

3

Let $P = 3$ $\quad S = a^3 b^6 a^3$

Case 1: v and y contain one type of symbol.

$\underbrace{aaabbbbb}_{u}\ \underbrace{b}_{v}\ \underbrace{b}_{x}\ \underbrace{a}_{y}\ \underbrace{aa}_{z}$

$uv^i x y^i z$

eg. shown for RL: ½

(5)

$i = 2$

$\underbrace{aaa\,bbbb}_{u}\ \underbrace{bb}_{v^i}\ \underbrace{b}_{x}\ \underbrace{aa}_{y^i}\ \underbrace{aa}_{z} = a^3 b^7 a^4 \notin L$

Case 2: v and y contain different symbol

$\underbrace{aa}_{u}\underbrace{a}_{v}\ \underbrace{bb}_{\bullet}\underbrace{bbbb}_{y}\ \underbrace{aaa}_{z}$

$\underbrace{aa}_{u}\ \underbrace{abab}_{v^i}\ \underbrace{bbbbb\ bbbbb}_{y^i}\ \underbrace{aaa}_{z} = a^3 bab^{11}a^3 \notin L$

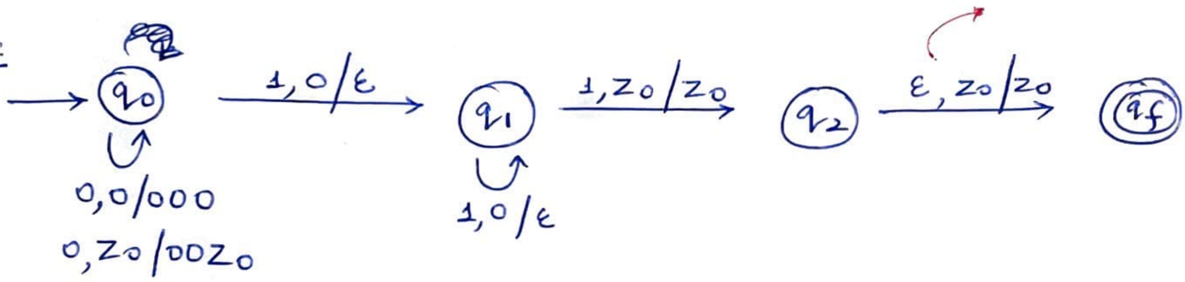
(2)

Q5

b) $0^n 1^{2n+1} = 0^n . 1^{2n} . 1$

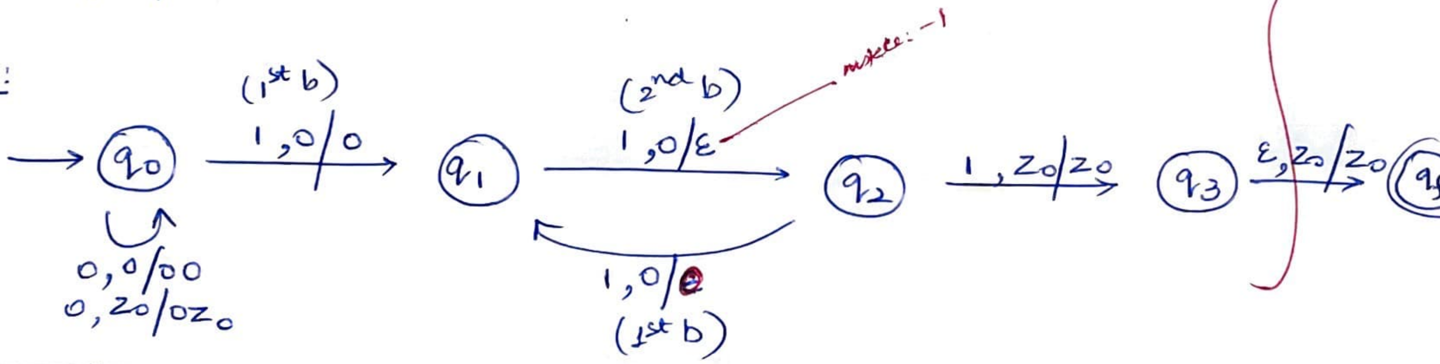
Cond wrong place: 2.

Way 1:



(5)

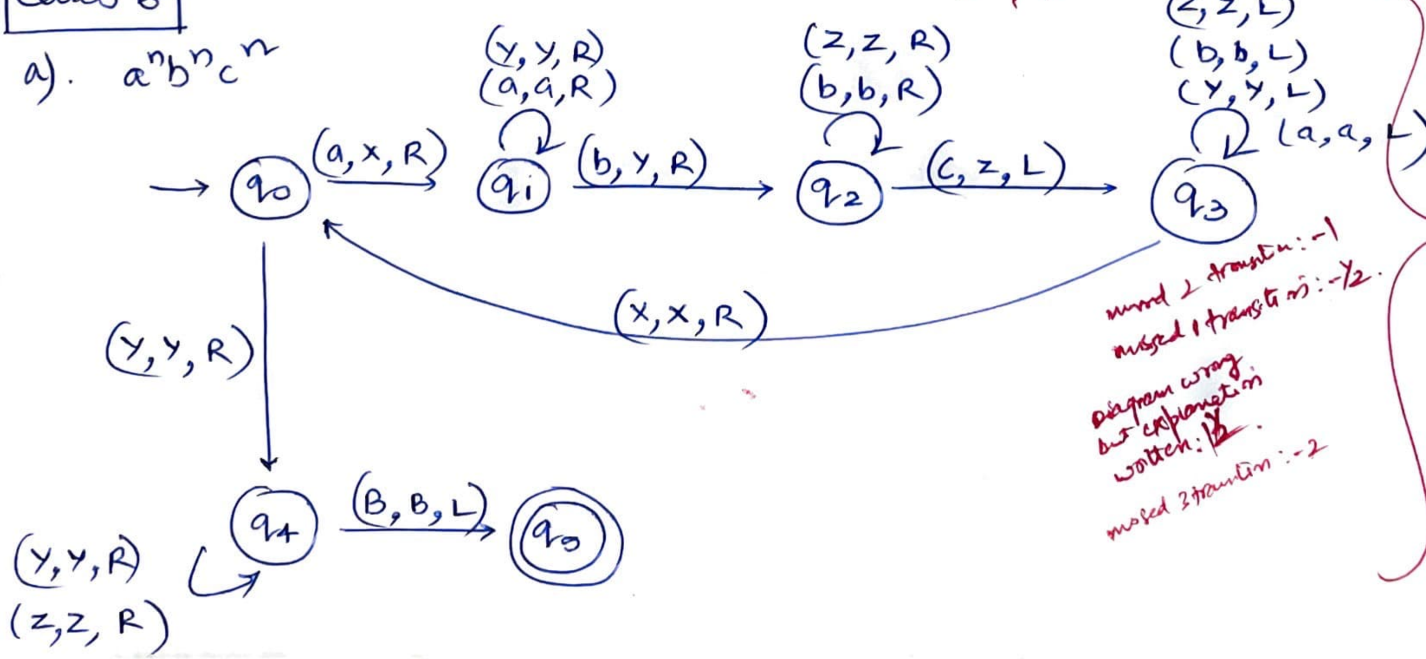
Way 2:



Ques 6

a). $a^n b^n c^n$

Attempt: ½



(5)

Q6: i).

b). Pumping Lemma for RL:

A is regular language, pumping length P. 1½

string S where $|S| \geq P$, divided into 3 parts $S = xyz$

½ $xy^iz \in A$ for $i \geq 0$

½ $|y| > 0$

½ $|xy| \leq P$

Ambiguity in Grammar:

more than 1 left most derivation, more than 1 right most derivation or more than 1 parse tree. 1

ii). PCP

$A = w_1 w_2 \cdots w_n$ $B = v_1 v_2 \cdots v_n$ 1½

without Eq: ½

there exist a PC Solution if $w_i w_j \cdots w_k = v_i v_j \cdots v_k$

Church's Thesis

Every computation that can be carried out in real world can be performed by a TM. 1

6