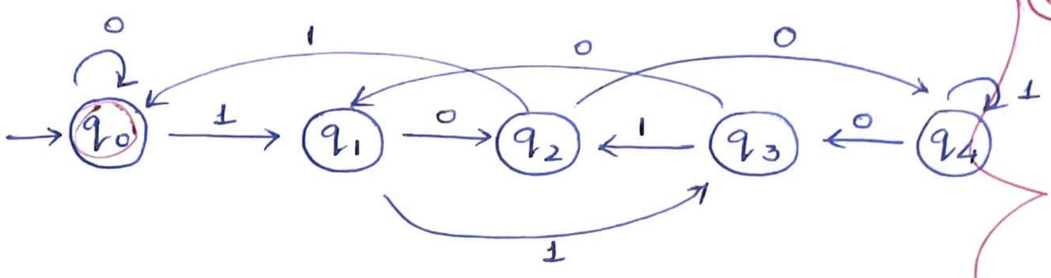
1

Ques 1

(A)

	0	1
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



5

(B.) Pumping lemma for RL:

A is a regular language, pumping length P

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

$xy^iz \in A$ for $i \geq 0$

$|y| > 0$

$|xy| \leq P$

3

$L = \{0^n \mid n \text{ is a perfect square}\}$

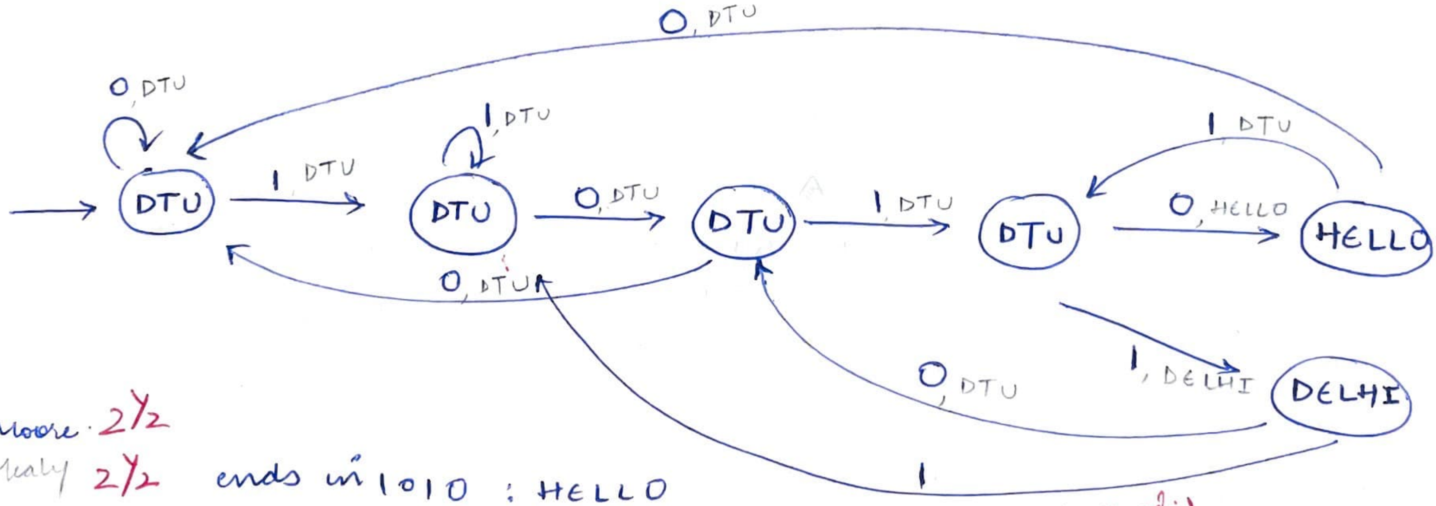
$S = 0^4$ and $P = 3$

$\underbrace{0}_{x}\underbrace{00}_{y}\underbrace{0}_{z}$ $\qquad$ $\underline{0}_{x}\ \underline{0000}_{y^2}\ \underline{0}_{z}$: $0^6 \notin L$

2

Ques 2

(A)



Moore 2½

Mealy 2½

ends in 1010 : HELLO

ends in 1011 : DELHI

otherwise : DTU

Shown only required : 1

Not all transitions shown : 3

1 transition wrong : 4

Q2

(B) no of 0's $\neq$ no. of 1's 3

Stm PDA : 1

$S \to P \mid Q$

$P \to XAX \mid PP$ P : derive strings with extra a's

$Q \to XBX \mid QQ$ Q : derive strings with extra b's

$X \to aXb \mid bXa \mid XX \mid \varepsilon$ X : derive equal no. of a's & b's

$A \to aA \mid a$ A : derive only a's

$B \to bB \mid b$ B : derive only b's

Chomsky classification.

Regular language $\to$ Regular Grammar
Context free language $\to$ Context free Grammar
Context Sensitive language $\to$ Context sensitive Grammar
Recursively Enumerable language $\to$ Unrestricted Grammar

2

Ques 3

(A) Ardens Theorem : $R = Q + RP$ $R = QP^*$ 1

$A = B0 + \varepsilon$
$B = A1 + D0$
$C = A0 + B1$
$D = C0 + E0$
$E = B1$

$\to$

$A = B0 + \varepsilon$
$B = A1 + D0$
$C = A0 + B1$
$D = C0 + B10$

$\to$

$A = B0 + \varepsilon$
$B = A1 + D0$
$D = A00 + B10 + B10$

$\downarrow$

$A = B0 + \varepsilon$
$B = A1 + D0$
$D = A00 + B10$

$\leftarrow$

$A = B0 + \varepsilon$
$B = A1 + A000 + B100$

only equation : 1
only 3 as [illegible] : 3
only if as first : 2
[illegible] : 3
[illegible] correct

$$\underbrace{B}_{R} = \underbrace{A(1+000)}_{Q} + \underbrace{B}_{R}\underbrace{100}_{P}$$

$$B = A(1+000)(100)^*$$

3

$$\underbrace{A}_{R} = \underbrace{A}_{R}\,\underbrace{(1+000)(100)^{*}0}_{P} + \underbrace{\varepsilon}_{Q}$$

$$A = \left((1+000)(100)^{*}0\right)^{*}$$

4

$$B = \left((1+000)(100)^{*}0\right)^{*}(1+000)(100)^{*}$$

$$C = \underbrace{\left((1+000)(100)^{*}0\right)^{*}}_{A}\underbrace{0}_{0} + \underbrace{\left((1+000)(100)^{*}0\right)^{*}(1+000)(100)^{*}}_{B}\underbrace{1}_{1}$$

$$E = \underbrace{\left((1+000)(100)^{*}0\right)^{*}(1+000)(100)^{*}}_{B}\underbrace{1}_{1}$$

Q3

(B) Yes. } 1

i)

$S \to bA \mid aB$
$A \to bAA \mid aS \mid a$
$B \to aBB \mid bS \mid b$

$S \to YA \mid XB$
$A \to YC \mid XS \mid a$
$B \to XD \mid YS \mid b$
$X \to a$
$Y \to b$
$C \to AA$
$D \to BB$

} 2

ii)

$S \to AB$
$A \to BS \mid b$
$B \to SA \mid a$

$\xrightarrow[\text{Symbol}]{\text{new start}}$

$S' \to S$
$S \to AB$
$A \to BS \mid b$
$B \to SA \mid a$

$\longrightarrow$

$S' \to S$
$S \to bB \mid aSB$.
$A \to b \mid aS \mid SAS.$
$B \to a \mid SA$

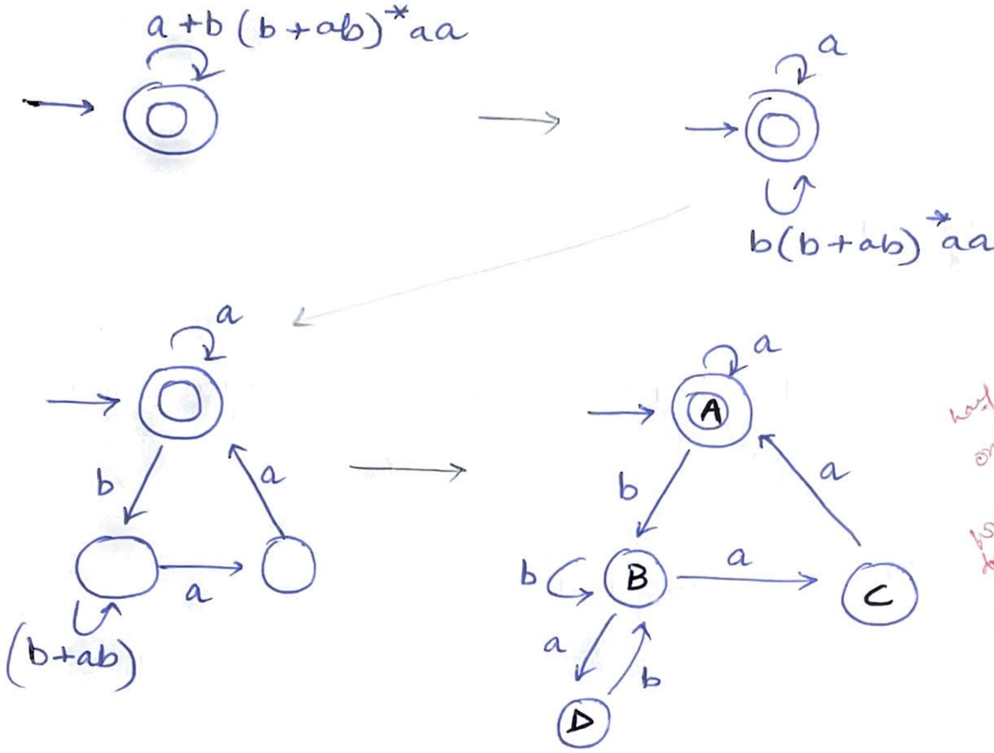
} 2

$A \to BS \to SAS \to ABAS \to bBAS.$
$A \to BS \to aS.$ ✓
$A \to b$ ✓

$B \to SA \to ABA \to bBA.$
$ABA \to BSBA \to SASBA.$
$BSBA \to aSBA.$
$B \to a$

Ques 4

(A) Equivalence of 2 FA:
Language accepted is same. } 1



half NFA: 1
only NFA: 2.
wrong dead state: 2.
Every mistake: 3.

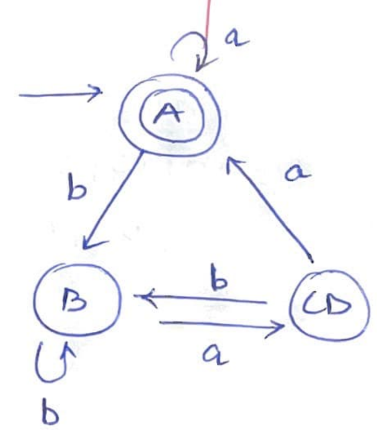
4

Convert NFA to DFA

	a	b
→ *A	A	B
B	CD	B
C	A	ϕ
D	ϕ	B

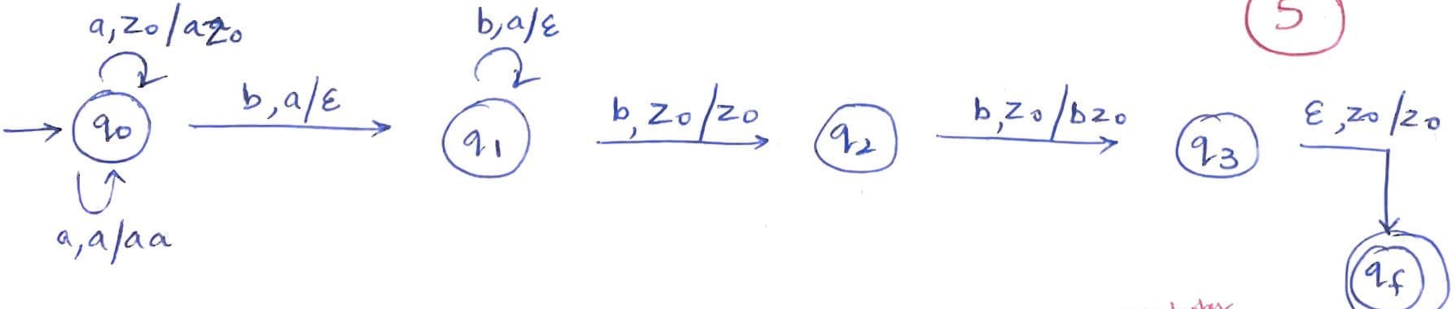
→

	a	b
A	A	B
B	CD	B
CD	A	B



(B) $a^n b^{n+2}$

5



Not proper entry: 4
Done for $a^n b^n$: 2

Ques 5 (5)

(A) 'A' is a CFL, pumping length 'p', any string s where $|s| \geq p$ can be divided into 5 pieces $s = u\cancel{v}xyz$ such that

$uv^i xy^i z$ is in A for every $i \geq 0$
$|vy| > 0$
$|vxy| \leq p$

(3)

$a^3 b^3 c^3$ $\quad p = 5$

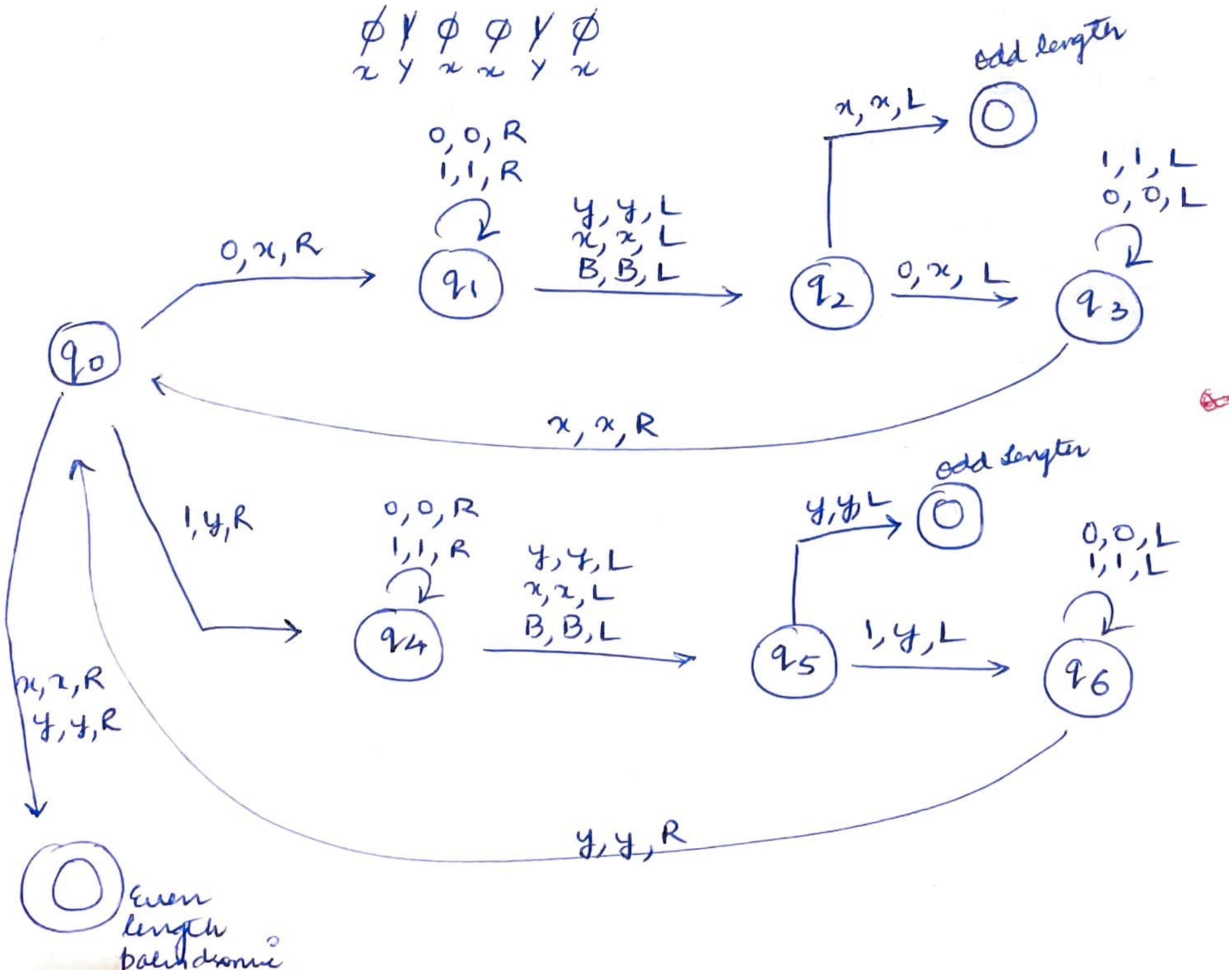
$\underbrace{aaa\,b}_{u}\underbrace{b}_{v}\underbrace{b}_{x}\underbrace{c}_{y}\underbrace{cc}_{z}$

(2)

$uv^i xy^i z$ $\quad i = 2$ $\quad \underbrace{aaab}_{u}\ \underbrace{bb}_{v^2}\ \underbrace{b}_{x}\ \underbrace{cccc}_{y^2}\ \underbrace{c}_{z} \Rightarrow a^3 b^4 c^5 \notin L$

(B) UTM: One TM to solve all problems (1)

TM for Palindromic strings:

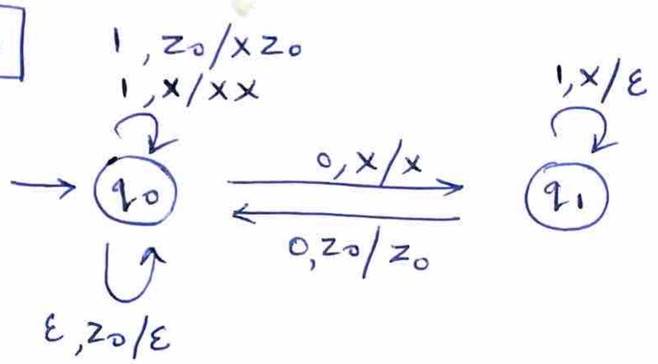


(4)

Single tape: 3
~~Complete~~ | Single tape: 2
with multi-tape: 1

Ques 6

(A)



Language: $1^n 0 1^n 0$

5

Grammar: $S \to A0$

$A \to 1A1 \mid 0$

Proper method
Solving everything: 4

algo method
first not shown: 2

Shortcut: $1^n 0 1^n 0$: 3.

(B) Halting problem: ~~It is~~ whether the machine will halt on an
i). input which belongs to language and one which doesnot belong to language. Halting problem for TM is undecidable.

$1\frac{1}{2}$

Churchs Thesis: Every computation that can be carried out in real world can be performed by a TM.

1

ii). PCP:

$A = w_1 w_2 \ldots w_n \qquad B = v_1 v_2 \ldots v_n$

there exist a PC solution if $w_i w_j \ldots w_k = v_i v_j \ldots v_k$

1

Myhill Nerode Theorem:

used for minimization of DFA.

a) list all state pairs

b) mark final non final pairs.

c) mark additional distinguishable pairs.

d) combine Remaining states.

$1\frac{1}{2}$