No :

Date:

Automata theory [2020] SCS 2212

Part (A)

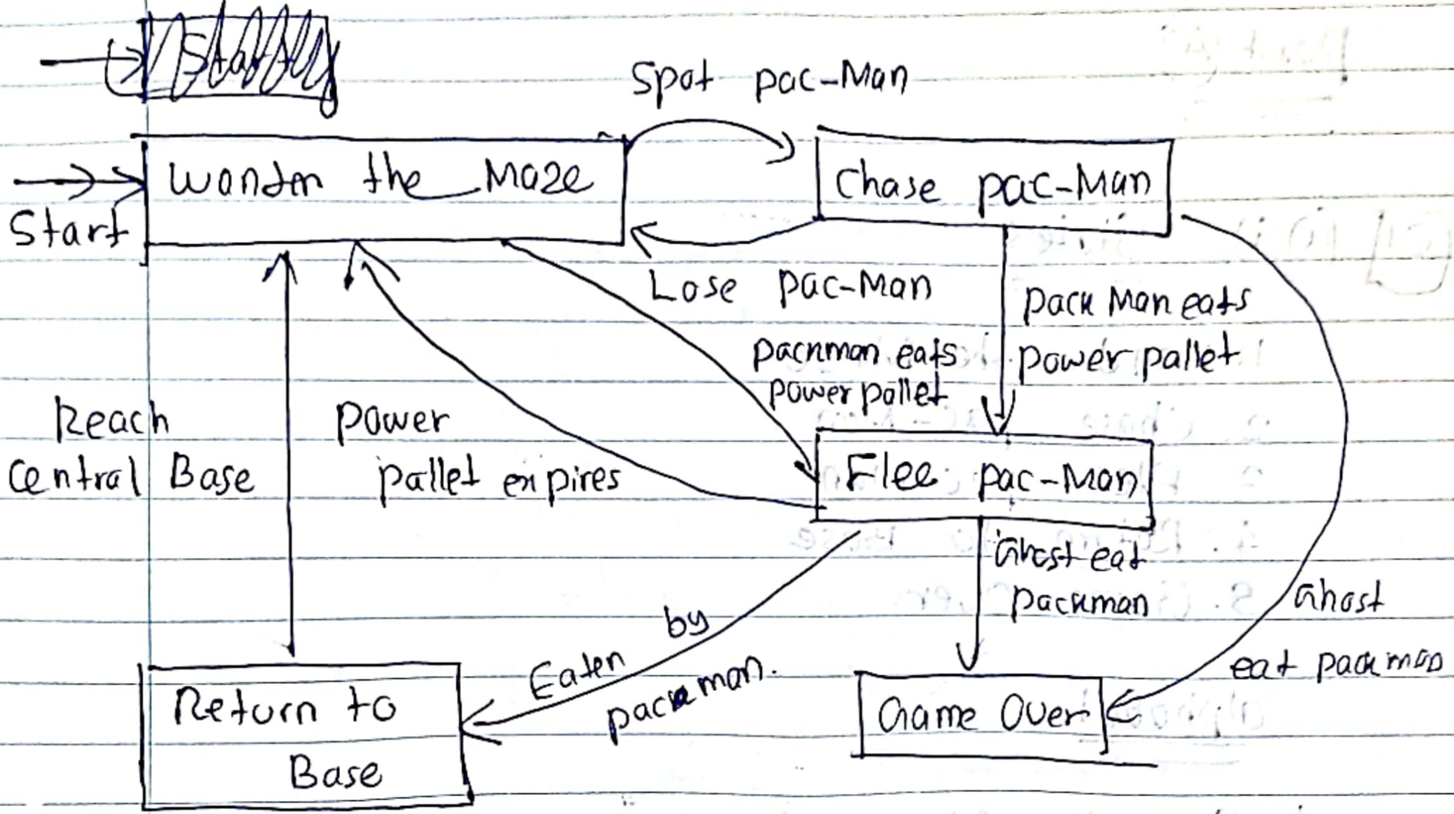
[01] (a)(i). States

1. Wander the Maze
2. Chase pac-Man
3. Flee pac-Man
4. Return to Base
5. Game over.

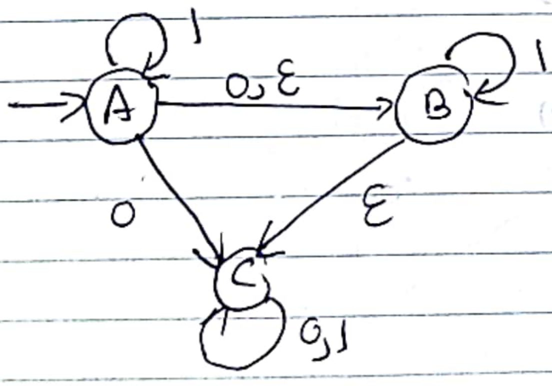
alphabet

1. Spot pac-Man
2. Lose pac-Man
3. pac-Man eat power pallet
4. power pallet expires
5. Reach central Base
6 Eaten by pac-Man
7. Eaten By ghost.

(ii).



(b) NFA ⟶ DFA



A: ε 0 ε
A → B → B, C
B → C, ϕ → C
C → C → C

A: ε 1 ε
A → A → A
B → B → B, C
C → C → C

	0	1
A	{B,C}	{A,B,C}
B	C	{B,C}
C	C	C

C: ε 0 ε
C C C

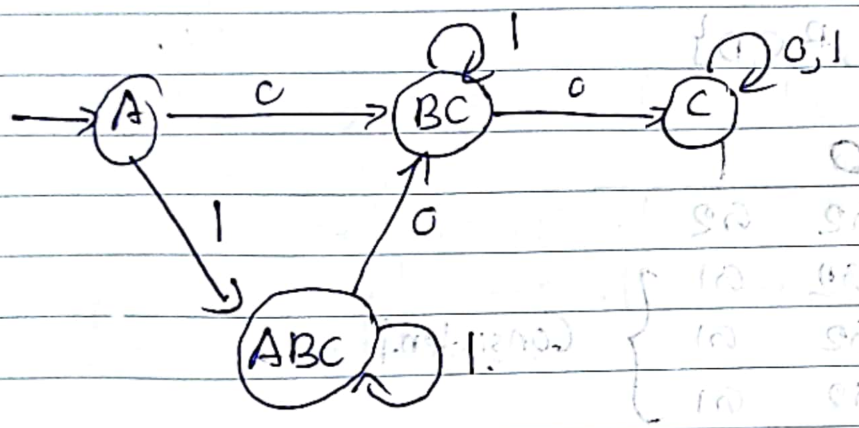
B: ε 0 ε
B ϕ ϕ
C C C

C: ε 1 ε
C C C

B: ε 1 ε
B B B, C
C C C

NFA to DFA

	0	1
A	BC	ABC
BC	C	BC
ABC	BC	ABC
C	C	C



(c) B and D are in Same group {B,C,D}
hence B and D are non distinguishable

Non distinguishable

$B \xrightarrow{0} C$ $\quad$ $B \longrightarrow E$ $\quad$ ∴ Non distinguishable

$B \xrightarrow{0} C$ $\quad$ $D \xrightarrow{1} E$

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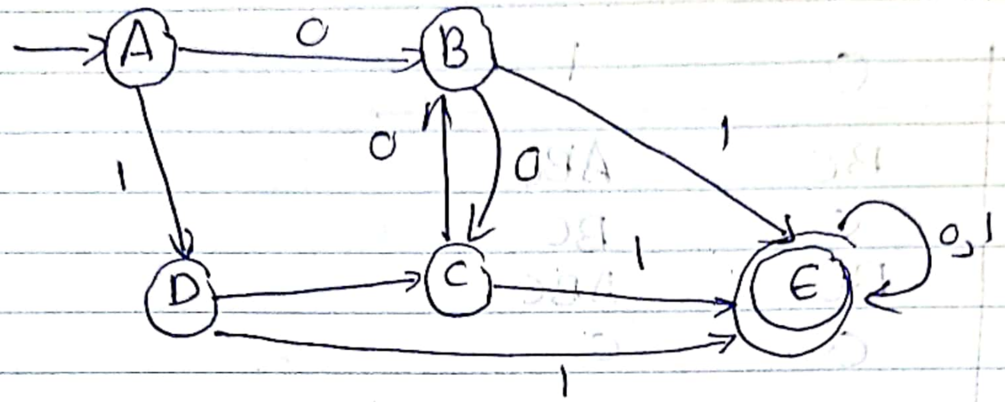
(ii).



$G1 = \{E\}$

$G2 = \{A, B, C, D\}$

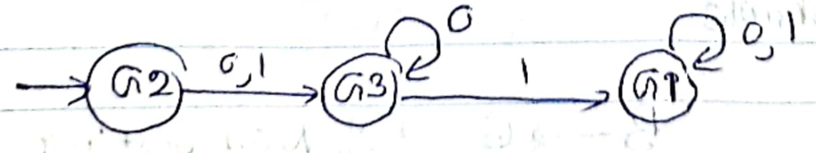
G2	0	1
A	G2	G2
B	G2	G1
C	G2	G1
D	G2	G1

} Consistent

$G1 = \{E\}$

$G2 = \{A\}$

$G3 = \{B, C, D\}$



(d) Moore machine output depends only on state.
Mealy machine output depends on Input and State

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Q2 (a) $L = [\wedge 11 \{2, \} \$]$

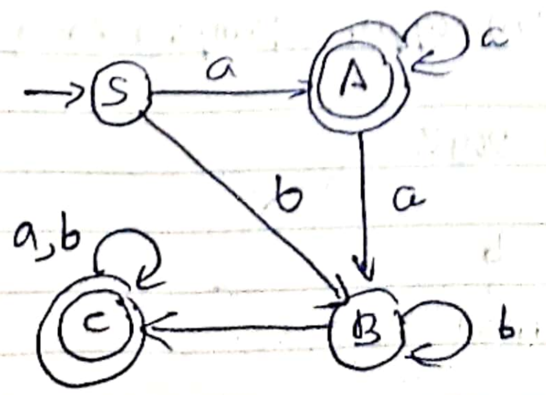
$(0+1)^* 11 (0+1)^* 11 (0+1)^*$

(b) $S \to Ab | Ba | C$
$A \to Bb | Aa | a$
$B \to Ba | \epsilon$
$C \to Ba | Ab | b$

rule 1 = Already applied
rule 2 = Already applied
rule 3 = $S \to aA \mid S \to bC$
rule 4 = $B \to bA \mid A \to aA \mid B \to aB \mid B \to aC \mid A \to bC$
rule 5 = $A \to b \mid B \to a$

$S \to aA | bC$
$B \to bA | aB | aC | a$
$A \to aA | bC | b$

(c) $S \to aA | bB$
$A \to aA | aB | a$
$B \to bB | aC$
$C \to a | b$.



(d)

$S \to aA \mid bB$
$A \to aA \mid aB \mid bC$
$B \to aD \mid bB$
$C \to aF \mid bD$
$D \to bF$
$F \to \varepsilon$

(e) $(a(ab+bb)^*)^+ + (bb(a+b)^+)^*$ $S \to A \mid B$

$(a(ab+bb)^*)^+$ $A \to CA \mid C$
$a(ab+bb)^*$ $C \to a \mid aD$
$(ab+bb)^*$ $D \to ED \mid E$
$(ab+bb)$ $E \to F \mid G$
ab $F \to aH, H \to b$
bb $G \to bI, I \to b$

$B \to JB \mid G$
$bb(a+b)^+$ $J \to bK \mid K \to L$
$b(a+b)^+$ $L \to bM \mid M \to N$
$(a+b)^+$ $N \to aN \mid bN \mid a \mid b$

(f) $L = \{a^n b^{n+1} ; n \geq 0\}$

* Assum L is regular,
* Since L is infinite, we can apply pumping lemma,

$m \in \mathbb{Z}$ $w = a^m b^{m+1} = xyz$

$\underbrace{aaa}_{m}$ $\underbrace{bb..b}_{m+1}$

$\underbrace{aa..}_{x}\underbrace{a...a}_{y}$ $\underbrace{b...b}_{z}$ $|xy| \leq m$

$|y| \geq 1$

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$y = a^k$

$$\underbrace{\overbrace{a..a \quad a...a \quad a..a}^{m+k}}_{} \quad \overbrace{b..b}^{m+1}$$

$$\underbrace{a..a}_{x} \quad \underbrace{a...a}_{y} \quad \underbrace{a..a}_{y} \quad \underbrace{b..b}_{z}$$

$a^{m+k} b^{m+1} \in L$ Contradiction

$\therefore$ language is not regular

$\boxed{\text{Part B}}$

(a) (i) intersection Complement

(ii). Context free

(iii). chomsky normal form

(iv) Unit

(v). Greibach

(i). $L = \{b, aa, aaaab, aab, \ldots\}$.

$S \rightarrow ABb$
$\rightarrow aBaBb$
$\rightarrow aaBb$
$\rightarrow aaAb$
$\rightarrow aaaBab$
$\rightarrow aaaab$

$S \rightarrow ABb$
$\rightarrow aBaBb$
$\rightarrow a.$

aaaab accept above grammer

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(d)
(i)

$S \to abAB$
$A \to aAB \mid \lambda$
$B \to BAb \mid A \mid \lambda$

Remove all λ-productions

$S \to abAB \mid abB$
$A \to aAB \mid aB$
$B \to BAb \mid A \mid Bb \mid \lambda$

$S \to abAB \mid abB \mid abA \mid ab$
$A \to aAB \mid aB \mid aA \mid a$
$B \to BAb \mid A \mid Bb \mid Ab \mid b$

Remove all unit production

$S \to abAB \mid abB \mid abA \mid ab$
$A \to aAB \mid aB \mid aA \mid a$
$B \to BAb \mid aAB \mid aB \mid aA \mid a \mid Bb \mid Ab \mid b$

No useless productions.

$S \to T_aT_bAB \mid T_aT_bB \mid T_aT_bA \mid T_aT_b$
$A \to T_aAB \mid T_aB \mid T_aA \mid a$
$B \to BAT_b \mid T_aAB \mid T_aB \mid T_aA \mid a \mid BT_b \mid AT_b \mid b$

$T_a \to a$
$T_b \to b$

$S \to T_cT_D \mid T_cB \mid T_cA \mid T_aT_b$
$A \to T_aT_D \mid T_aB \mid T_aA \mid a$
$B \to T_eT_b \mid T_aT_D \mid T_aT_B \mid T_aA \mid a \mid BT_b \mid AT_b \mid b$
$T_a \to a$
$T_b \to b$

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$T_c \rightarrow T_a T_b$

$T_D \rightarrow AB$

$T_e \rightarrow BA$

Chomsky Normal Form. Greibach Normal Form

$A \rightarrow BC$ or $A \rightarrow aX$

$A \rightarrow a$ $aXXX..$

Q4 (i)

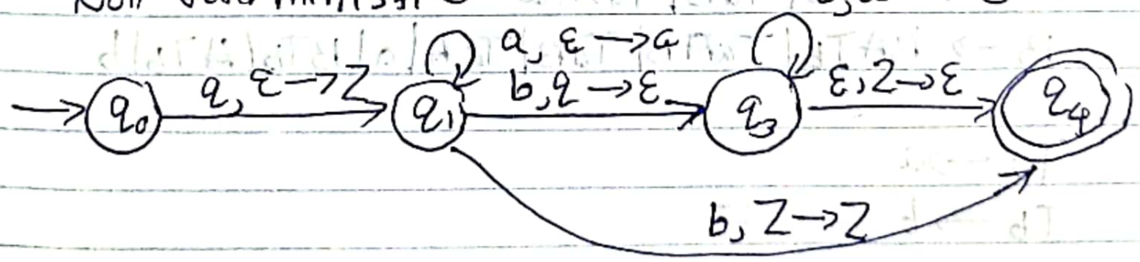
Because finite automata have strictly finite memories where as the recognition of a context free language may require storing on bound amount of information

(ii).

when scanning a string from language $L = \{a^n b^n : n \geq 0\}$, we must not only check that all a's precede the first b,

we also count no. of a's.

(b) Non deterministic C



DFA must have exactly one transition for each possible input symbol from each state

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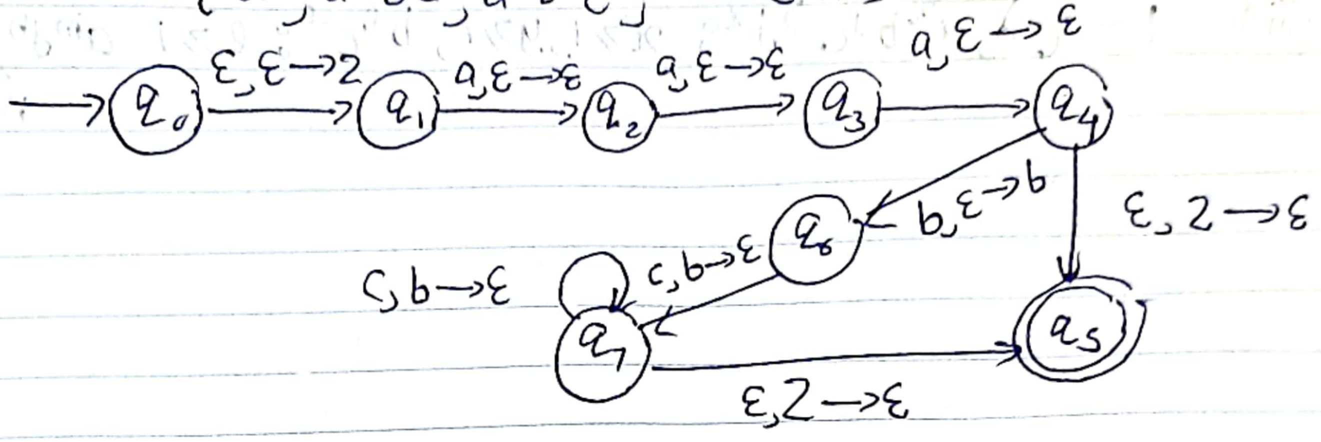
$L = \{a^3, a^3bc, a^3b^2c^2, a^3b^3c^3 \ldots\}$

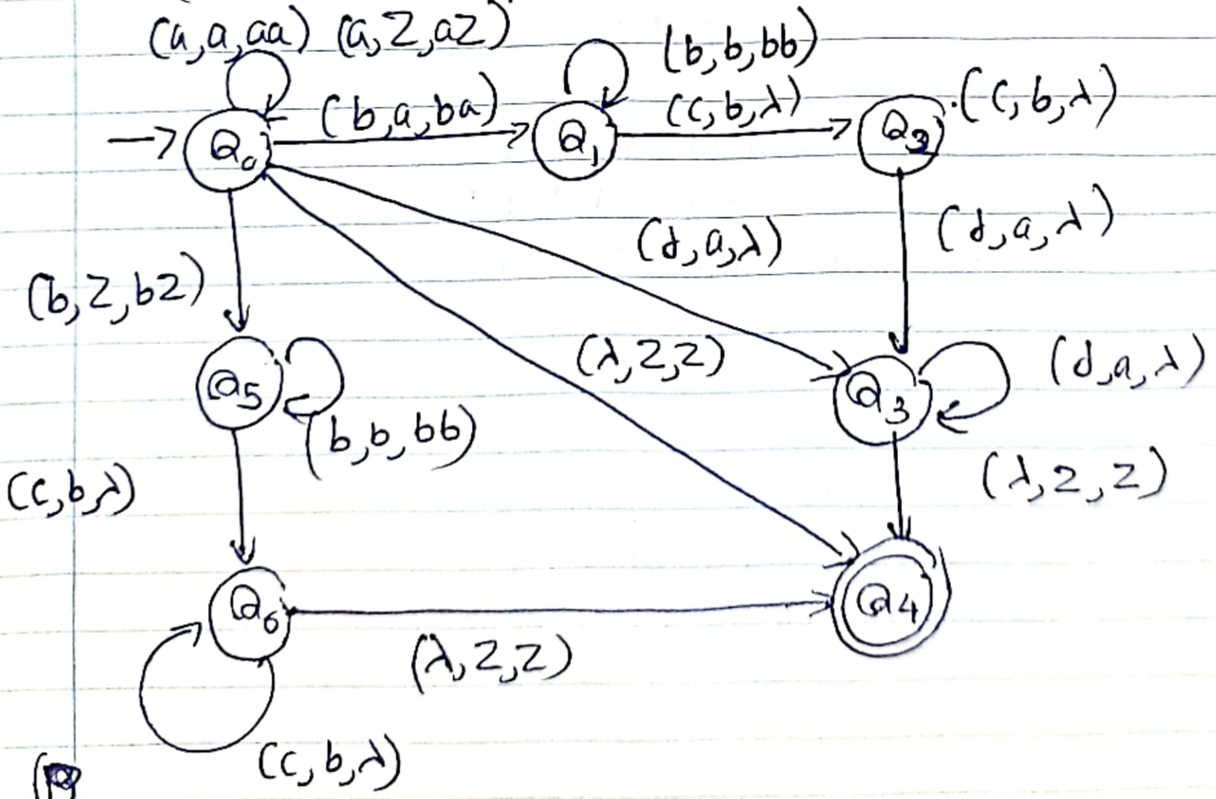
(c).



(d) (i) $L = \{a^x b^y c^y d^x : x \geq 1, y \geq 1, b^l c^l : l \geq 1\}$

(ii) (a) ad, aadd, aaaddd...

(b) empty input string.



(e)

(iii) $L = \{\lambda, a^x b^y c^y d^x : x \geq 1, y \geq 1, b^l c^l : l \geq 1 \text{ and } a^m d^n, m \geq 1, n \geq 1\}$.