

Ali Haider

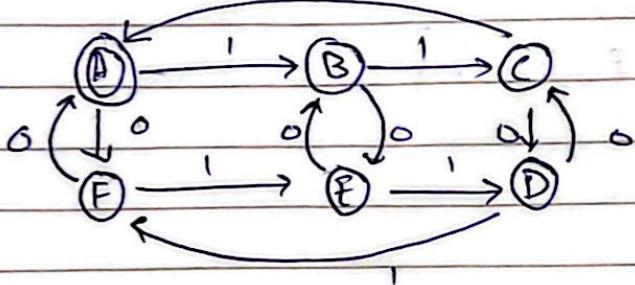
2210936

(C)

Date:

Automata A-2

Q1 (a)



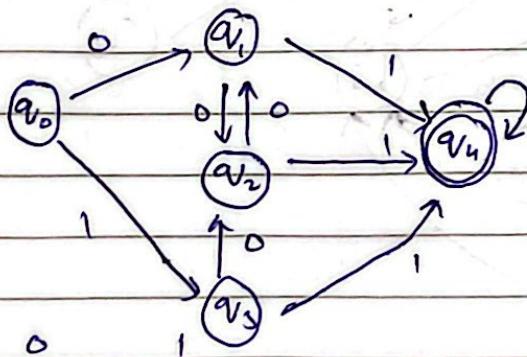
A ⁺	F	B
B	E	C
C	D	A
D	L	F
E	B	D
F	A	E

2-equivalence

$$\{B, D, E\}, \{C\}, \{F\}, \{A\}$$

$$\{B\}, \{D\}, \{E\}, \{C\}, \{F\}, \{A\}$$

(b)



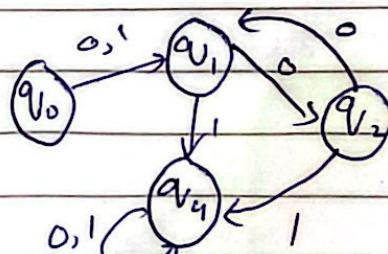
0-equivalence

$$\{q_0, q_1, q_2, q_3\} \sim \{q_4\}$$

$$\{q_0, q_2\}, \{q_1, q_3\}, \{q_4\}$$

$$\{q_0\}, \{q_2\}, \{q_1, q_3\}, \{q_4\}$$

q ₀	q ₁	q ₃
q ₁	q ₂	q ₄
q ₂	q ₁	q ₃
q ₃	q ₂	q ₄
q ₄	q ₀	q ₃



c) 0-equivalence :-

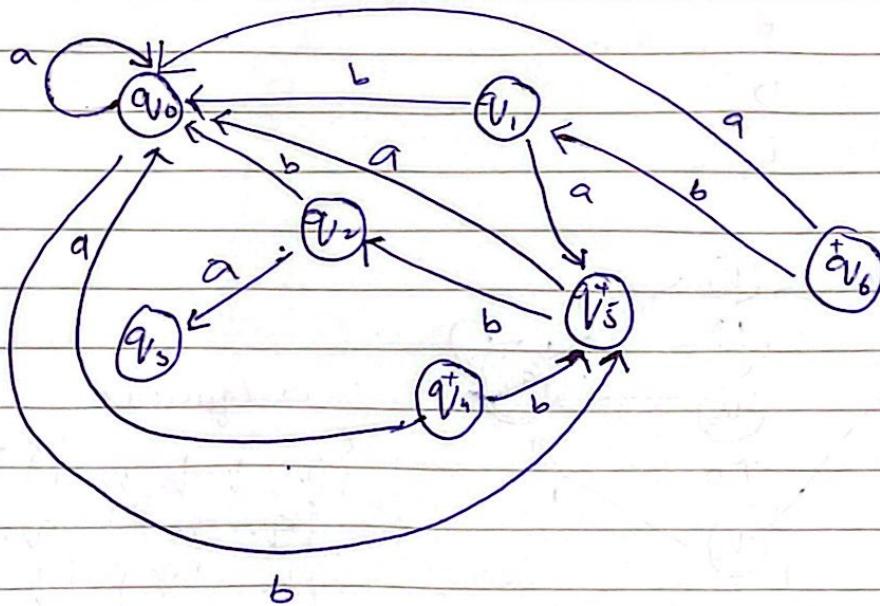
$$\{A, B, C, D, H\} \quad \{E, F, G\}$$

1 - equivalence :-

$$\begin{array}{ll} \{A, B\} & \{H\} \\ \{C\} & \{E\} \\ \{D\} & \{F, G\} \end{array}$$

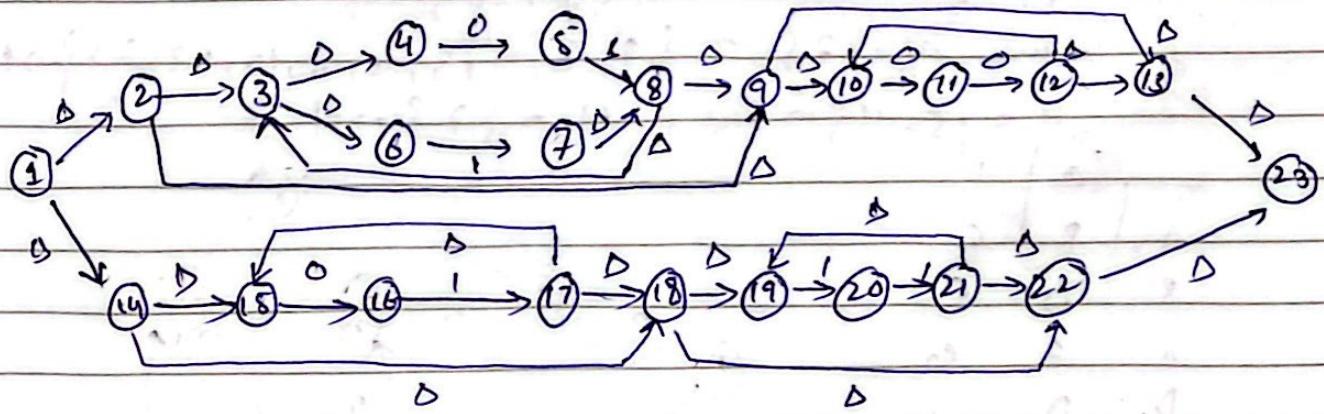
2 - equivalence :-

$$\{A, B\}, \{C\}, \{D\}, \{H\}, \{E\}, \{F\}, \{G\}$$



Question No 2.

$$(0+1)^*(00)^* + (01)^*(11)^*$$

DFA:-

$\Delta\text{-closure } [1] = \{1, 2, 3, 4, 5, 6, 9, 10, 13, 23, 14, 15, 18, 19, 22\} \rightarrow A$

$$A_0 = \{5, 11, 16\} \rightarrow B, \quad A = \{7, 20\} \rightarrow C$$

$\Delta\text{-closure } \{5, 11, 16\} = \{5, 8, 3, 4, 5, 9, 10, 13, 23, 1, 16\} \rightarrow B$

$$B = \{5, 11, 12\} \rightarrow D, \quad B = \{7, 17\} \rightarrow F$$

$\Delta\text{-closure } \{7, 20\} = \{7, 8, 9, 4, 3, 6, 10, 13, 23, 20\} \rightarrow C$

$$C = \{5, 11\} \rightarrow F, \quad C = \{7, 21\} \rightarrow G$$

$\Delta\text{-closure } \{5, 11, 12\} = \{5, 8, 3, 4, 6, 9, 10, 13, 23, 11, 12\} \rightarrow D$

$$D = \{5, 11, 12\} \rightarrow D, \quad D = \{7\} \rightarrow H$$

$\Delta\text{-closure } = \{7, 17\} = \{7, 8, 9, 3, 4, 6, 10, 13, 23, 17, 15, 18, 22\} \rightarrow E$

$$E = \{8, 11, 16\} \rightarrow B, \quad E = \{7\} \rightarrow I$$

$\Delta\text{-closure } \neq \{8, 11\} = \{8, 5, 3, 4, 6, 9, 10, 13, 23, 11\} \rightarrow F$

$$F = \{5, 11, 12\} \rightarrow D, \quad F = \{7\} \rightarrow H$$

Date: _____

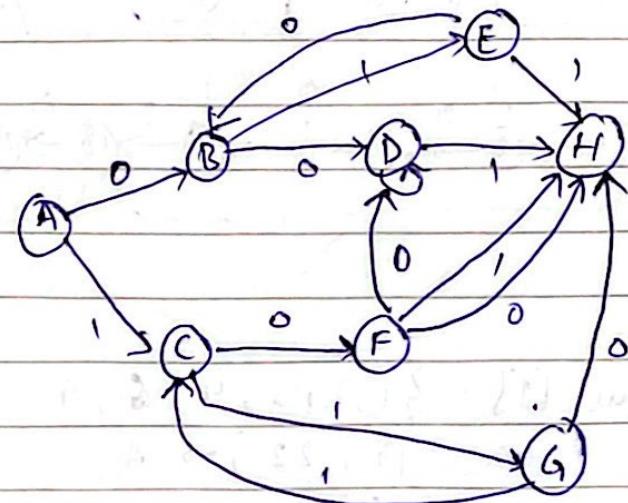
Δ -closure of $\{7, 12\} = \{7, 8, 9, 3, 4, 6, 10, 13, 23, 21, 19\} \rightarrow G$

$G = \{8, 11\} \rightarrow F$; $G = \{7, 20\} \rightarrow C$

Δ -closure of $\{7\} = \{7, 8, 9, 3, 4, 6, 10, 13, 23\} \rightarrow H$

$G+H = \{5, 11\} \rightarrow F$; $H = \{7\} \rightarrow H$

	0	1
A	B	C
B	D	F
C	F	G
D	D	H
E	B	H
F	D	H
G	F	C
H	F	H



Minimizing:-

0-equivalence:-

$$\{A, B, C, D, E, F, G\} \quad \{H\}$$

1-equivalence:-

$$\{A, B, C, G\} \quad \{D, E, F\} \quad \{H\}$$

2-equivalence:-

$$\{A\}$$

$$\{B\}$$

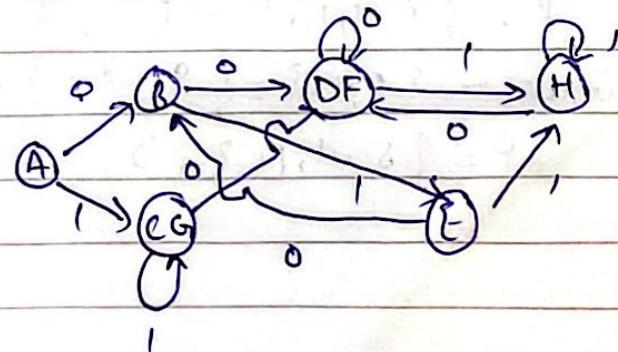
$$\{C, G\}$$

$$\{D, F\}$$

$$\{E\}, \{H\}$$

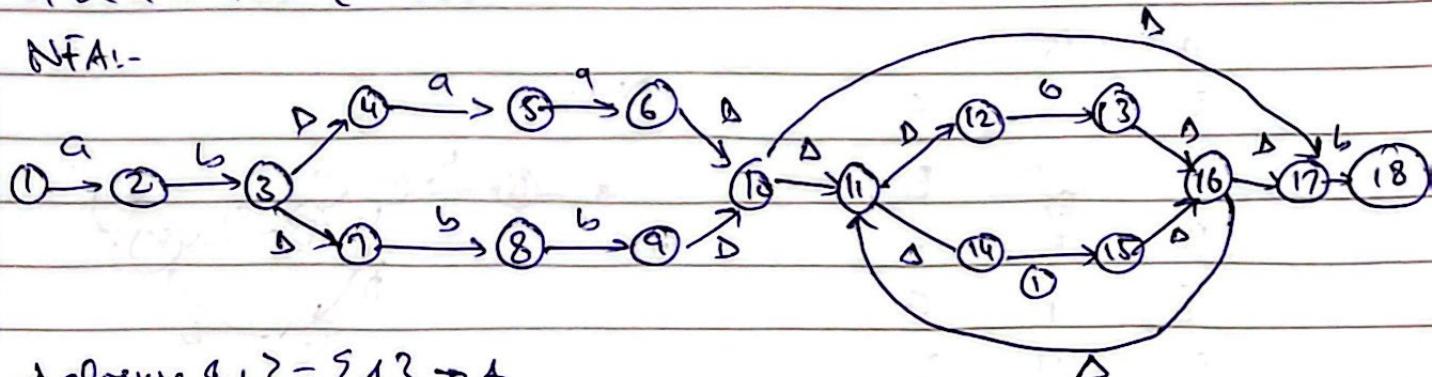
3-equivalence:-

$$\{A\}, \{B\}, \{C, G\}, \{D, F\}, \{E\}, \{H\}$$



$$\textcircled{2} \quad ab(a\alpha + bb)(\alpha + b)^* b$$

NFA:-



α -closure of $\{1\} = \{1\} \rightarrow A$

$A = \{2, 3\} \rightarrow B$, $B = \{3\}$

α -closure of $\{2, 3\} = \{2, 3\} \rightarrow B$

$B = \{3\}$, $b = \{3\} \rightarrow C$

α -closure of $\{3\} = \{3, 4, 7\} \rightarrow C$

$C = \{8\} \rightarrow D$, $c = \{8\} \rightarrow E$

α -closure of $\{8\} = \{8\} \rightarrow E$

$aD = \{6\} \rightarrow F$, $bD = \{3\}$

α -closure of $\{8\} = \{8\} \rightarrow E$

$aE = \{3\}$, $bE = \{9\} \rightarrow G$

α -closure of $\{G\} = \{6, 10, 17, 11, 12, 14\} \rightarrow H$

$aH = \{13\} \rightarrow K$, $bH = \{15, 18\} \rightarrow I$

α -closure of $\{9\} = \{9, 10, 11, 12, 14, 17, 6\} \rightarrow G$

$aG = \{13\} \rightarrow H$, $bG = \{15, 18\} \rightarrow I$

α -closure of $\{13\} = \{13, 6, 11, 12, 14\} \rightarrow H$

$aH = \{13\} \rightarrow H$, $bH = \{15\} \rightarrow J$

α -closure of $\{15, 18\} = \{15, 16, 11, 12, 14, 17, 18\} \rightarrow I$

$aI = \{13\} \rightarrow H$, $bI = \{15, 18\} \rightarrow I$

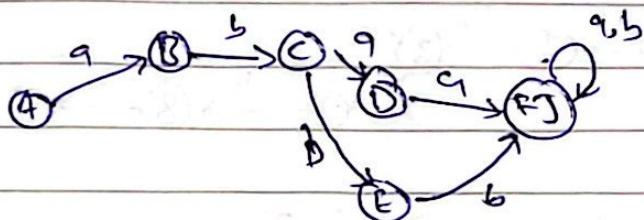
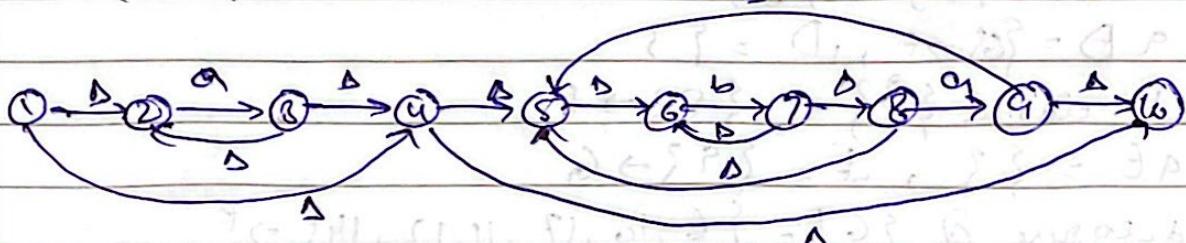
α -closure of $\{15\} = \{15, 16, 11, 12, 14, 17\} \rightarrow J$

$aJ = \{13\} \rightarrow H$, $bJ = \{15, 18\} \rightarrow I$

Date:

	a	b
A	B	-
B	-	C
C	D	E
D	F	-
E	-	G
F	H	I
G	H	I
H	H	J
I	H	I
J	H	I

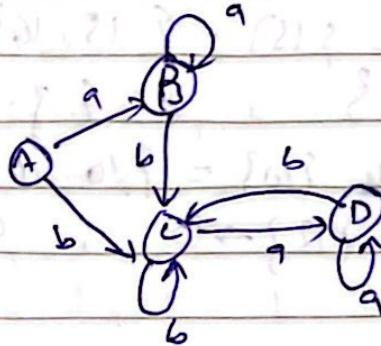
DFA :-

(3) $\alpha^* (b^* a)^*$ NFA :-

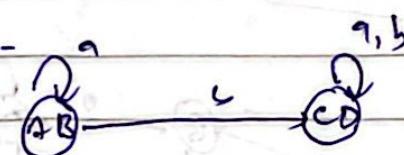
NFA to DFA:-

 α - closure $\{1\} = \{1, 2, 4, 5, 8, 6, 10\} \rightarrow A$ $\alpha^1 = \{3, 9\} \rightarrow B$, $\alpha^2 = \{7\} \rightarrow C$ $\alpha^3 = \{3, 9\} = \{3, 2, 4, 5, 6, 10, 8, 9, 10\} \rightarrow D$ $\alpha^4 = \{3, 9\} \rightarrow E$, $\alpha^5 = \{7\} \rightarrow C$ α closure of $\{7\} = \{7, 6, 8\} \rightarrow C$ $\alpha^6 = \{9\} \rightarrow D$, $\alpha^7 = \{7\} \rightarrow C$ α closure of $\{9\} = \{9, 5, 8, 6, 10\} \rightarrow D$ $\alpha^8 = \{9\} \rightarrow D$, $\alpha^9 = \{7\} \rightarrow C$

A	B	C
B	B	C
C	D	C
D	D	C

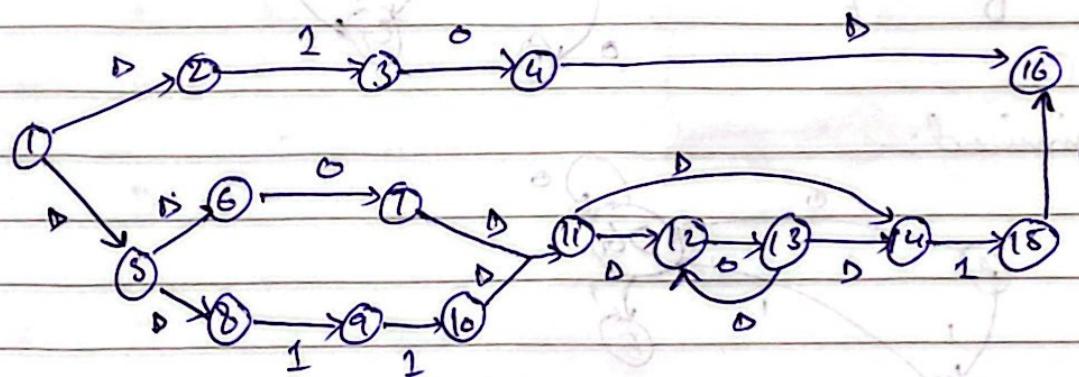


Minimized :-



(5)

$$10 + (0 + 11) 0^* 1$$

NFA \approx DFA -

$$\text{1-closure } \{1\} = \{1, 2, 5, 6, 8\} \rightarrow A$$

$$A \rightarrow \{7\} \rightarrow B, A = \{3, 9\} \rightarrow C$$

$$\text{2-closure } \{7\} = \{7, 11, 12, 14\} \rightarrow B$$

$$B = \{13\} \rightarrow D, B = \{15\} \rightarrow E$$

$$\text{2-closure } \{3, 9\} = \{3, 9\} \rightarrow C$$

$$C = \{4\} \rightarrow F, C = \{10\} \rightarrow G$$

$$\text{2-closure } \{13\} = \{13, 12, 14\} \rightarrow D$$

$$D = \{13\} \rightarrow D, D = \{15\} \rightarrow E$$

Date:

2 - closure $\{15\} = \{15, 16\} \rightarrow E$

$E = \{3\}$, $\epsilon = \{\}$

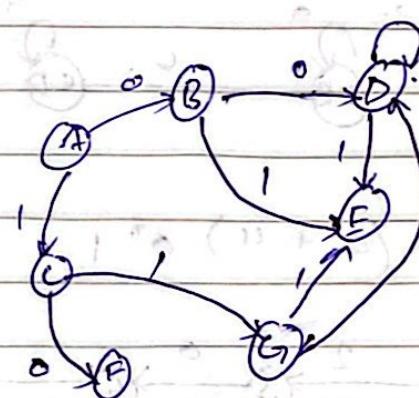
2 - closure $\{10\} = \{10, 16, 14, 12\} \rightarrow G$

$G_1 = \{13\} \rightarrow D$, $G_2 = \{15\} \rightarrow E$

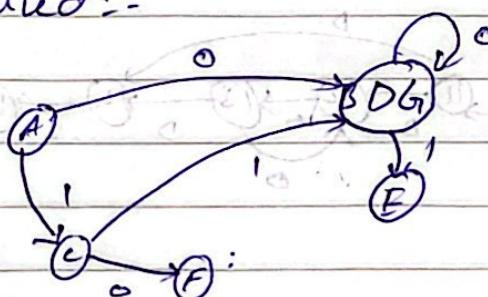
0 1

A	B	C
B	D	E
C	F	G
D	D	E
E	-	-
F	-	-
G	D	E

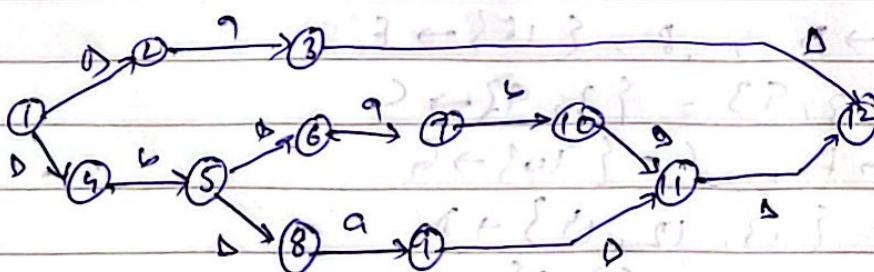
DFA :-



Minimized :-



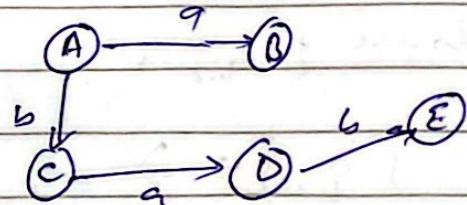
⑤ $a + b(ab + a)$



Date: _____

- △-closure $\{1\} = \{1, 1, 4\} \rightarrow A$
 $a^A = \{3\} \rightarrow B$, $b^A = \{5\} \rightarrow C$
 △-closure $\{3\} = \{3, 12\} \rightarrow B$
 $a^B = \{\}$, $b^B = \{\}$
 △-closure $\{5\} = \{5, 6, 8\} \rightarrow C$
 $a^C = \{7, 9\} \rightarrow D$, $b^C = \{\}$
 △-closure $\{7, 9\} = \{7, 9, 11, 12\} \rightarrow D$
 $a^D = \{\}$, $b^D = \{10\} \rightarrow E$
 △-closure $\{10\} = \{10, 12, 12\} \rightarrow E$
 $a^E = \{\}$, $b^E = \{\}$

	a	b
A	B	C
B	-	-
C	D	-
D	-	E
E	-	-

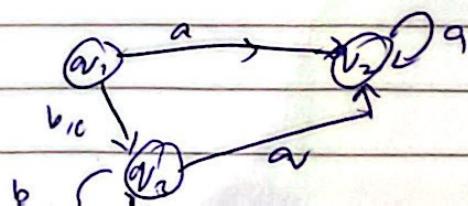


Q.3

NFA to DFA

- △-closure $\{A\} = \{A, B, D\} \rightarrow q_1 \Rightarrow q_1 = \{D\} \rightarrow q_2$, $a^{q_1} = \{C\} \rightarrow q_3$, $q_1 = \{C\}$
 △-closure $\{D\} = \{D\} \rightarrow q_2 \Rightarrow q_2 = \{D\} \rightarrow q_3$, $b^{q_2} = \{\}$, $q_2 = \{\}$
 △-closure $\{C\} = \{C, B, D\} \rightarrow q_3$
 $a^{q_3} = \{D\} \rightarrow q_2$, $b^{q_3} = \{D\} \rightarrow q_2$, $c^{q_3} = \{C\} \rightarrow q_1$

a_1	q_2	q_3	q_3
a_2	q_2	-	-
q_1	q_1	q_1	q_1



Δ - closure $\{q_0\} = \{q_1, q_2, q_3\} \rightarrow A$

$a^A = \{q_1\} \rightarrow B$, $b^A = \{q_2\} \rightarrow C$

Δ - closure $\{q_1\} = \{q_1\} \rightarrow B$

$a^B = \{q_2\} \rightarrow D$, $b^B = \{q_2\} \rightarrow C$

Δ - closure $\{q_2\} = \{q_1, q_2\} \rightarrow C$

Δ - closure $\{q_2\}$

$c = \{q_2\} \rightarrow D$, $d = \{q_2\} \rightarrow C$

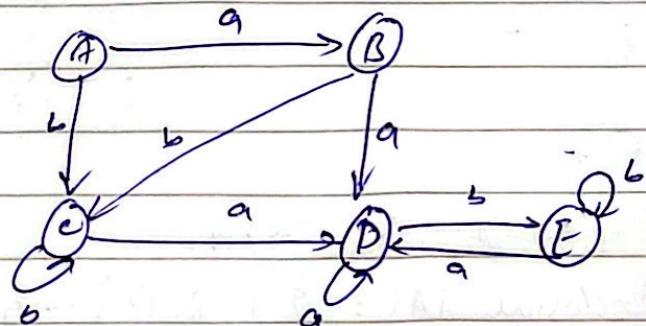
Δ - closure $\{q_2\} = \{q_2, q_3, q_4, q_1\} \rightarrow D$

$a^D = \{q_2\} \rightarrow D$, $b^D = \{q_3, q_2, q_5\} \rightarrow E$

Δ - closure $\{q_2, q_3, q_5\} = \{q_2, q_5, q_3, q_1\} \rightarrow E$

$a^E = \{q_2\} \rightarrow D$, $b^E = \{q_2, q_3, q_5\} \rightarrow E$

A	B	C
B	D	C
C	D	C
D	D	E
E	D	E

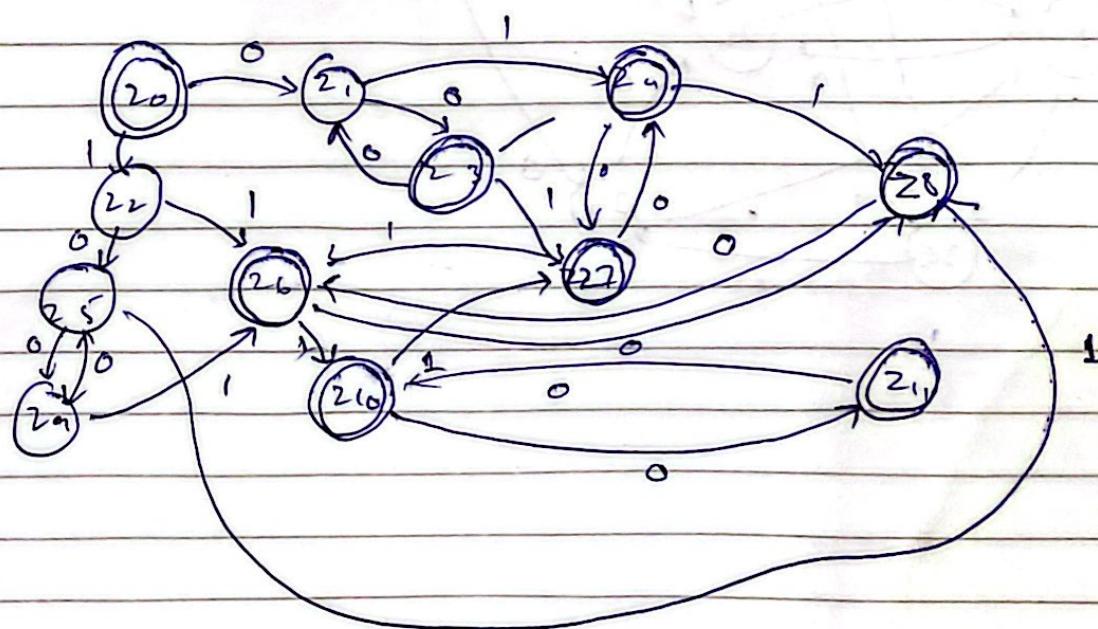


Date: _____

Q.4

a) DFA - 1 + DFA - 2

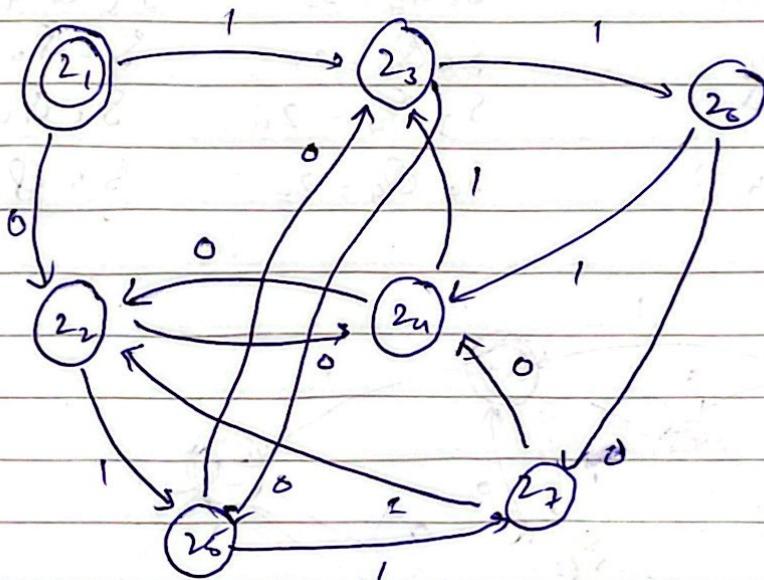
New state	old state	0	1
20	+ $S_0 Q_0$	$S_2 Q_1 = 21$	$S_1 Q_1 = 22$
21	$S_3 Q_1$	$S_0 Q_2 = 23$	$S_4 Q_1 = 24$
22	$S_1 Q_3$	$S_4 Q_1 = 25$	$S_2 Q_4 = 26$
23	+ $S_0 Q_2$	$S_3 Q_1 = 21$	$S_1 Q_4 = 27$
24	+ $S_4 Q_4$	$S_1 Q_4 = 22$	$S_5 Q_4 = 28$
25	$S_4 Q_2$	$S_1 Q_1 = 29$	$S_5 Q_3 = 28$
26	+ $S_2 Q_4$	$S_5 Q_4 = 28$	$S_0 Q_4 = 210$
27	+ $S_1 Q_4$	$S_4 Q_4 = 24$	$S_2 Q_4 = 26$
28	+ $S_5 Q_4$	$S_2 Q_4 = 26$	$S_3 Q_4 = 211$
29	$S_1 Q_1$	$S_4 Q_4 = 25$	$S_2 Q_4 = 26$
210	+ $S_0 Q_4$	$S_3 Q_4 = 211$	$S_1 Q_4 = 22$
211	+ $S_3 Q_4$	$S_0 Q_4 = 210$	$S_4 Q_4 = 24$



Date:

e (DFA .1)

N.S	0.S	0	1
2 ₁	A	2 ₂ = D	B = 2 ₃
2 ₂	D	2 ₄ = A	E = 2 ₅
2 ₃	B	2 ₅ = E	C = 2 ₆
2 ₄	A	2 ₂ = D	B = 2 ₃
2 ₅	E	2 ₃ = B	I = 2 ₇
2 ₆	C	2 ₇ = F	A = 2 ₄
2 ₇	F	2 ₆ = C	D = 2 ₂



Date: _____

 $f \setminus (DFA \cdot 2)^*$

NS	0 S	0	1
- 2 ₁	q ₀	2 ₂ = q ₁	q ₁ = 2 ₁
2 ₂	q ₁	2 ₄ = q ₂	q ₀ q ₄ = 2 ₅
2 ₃	q ₃	2 ₄ = q ₂	q ₀ q ₁ = 2 ₅
2 ₄	q ₂	2 ₂ = q ₁	q ₀ q ₄ = 2 ₅
+ 2 ₅	q ₀ q ₄	2 ₃ = q ₀ q ₁ q ₂	q ₀ q ₃ q ₄ = 2 ₇
+ 2 ₆	q ₀ q ₁ q ₄	2 ₈ = q ₀ q ₁ q ₂ q ₄	q ₀ q ₃ q ₈ = 2 ₂
+ 2 ₇	q ₀ q ₁ q ₂ q ₄	2 ₈ = q ₀ q ₁ q ₂ q ₄	q ₀ q ₃ q ₄ = 2 ₇
+ 2 ₈	q ₀ q ₁ q ₂ q ₄	2 ₈ = q ₀ q ₁ q ₂ q ₄	q ₀ q ₃ q ₄ = 2 ₇
2 ₉			

