

## Final

$S' \rightarrow S$	Null	$S' \text{ Prev}$	$S \rightarrow$
$S \rightarrow AB BCS$	$\{\epsilon, C\}$	$\{\epsilon, C\}$	$S \rightarrow AB BCS$
$A \rightarrow aA C$	$\{\epsilon, A, C\}$	$\{\epsilon, C\}$	$A \rightarrow a^* C$
$B \rightarrow bB b$	$\{\epsilon, S, A, C\}$	$\{\epsilon, A, C\}$	$B \rightarrow b^* B$
$C \rightarrow cC \lambda$	$\{\epsilon, S', S, A, C\}$	$\{\epsilon, S, A, C\}$	$C \rightarrow c^* C$
	$\{\epsilon, S', S, A, C\}$	$\{\epsilon, S', S, A, C\}$	

$S' \rightarrow S   \lambda$	chain $(S') = \{\epsilon, S'\}$
$S \rightarrow AB BCS B BC BS$	$(S) = \{\epsilon, S\}$
$A \rightarrow aA C a$	$(A) = \{\epsilon, A, C\}$
$B \rightarrow bB b$	$(B) = \{\epsilon, B\}$
$C \rightarrow cC c$	$(C) = \{\epsilon, C\}$

$S' \rightarrow AB BCS bB b BC BS \lambda$	Term	Prev
$S \rightarrow AB BCS bB b BC BS$	$\{\epsilon, S, A, B, C\}$	
$A \rightarrow aA cc c a$		
$B \rightarrow bB b$	Reach	Prev
$C \rightarrow cC c$	$S'$	New

$S' \rightarrow AB BCS B'B B b BC BS \lambda$	Reach	Prev	New
$S \rightarrow AB BCS B'B B b BC BS$	$\{S', S, A, B, C\}$	$S'$	$S, A, B, C$

$A \rightarrow A'A|CC|C|a'$

$B \rightarrow B'B'|B|b$

$C \rightarrow C'C|C'$

$A' \rightarrow a$

$B' \rightarrow b$

$C' \rightarrow c$



$$\begin{array}{c}
 S' \rightarrow AB \mid BT_1 \mid B'T_2 \mid b \mid BC \mid BS \mid \lambda \\
 S \rightarrow AB \mid BT_1 \mid B'T_2 \mid b \mid BC \mid BS \\
 A \rightarrow A'A \mid C'C \mid c \mid a \\
 B \rightarrow B'B \mid b \\
 C \rightarrow C'C \mid c \\
 T_1 \rightarrow CS \\
 T_2 \rightarrow B'B \\
 A' \rightarrow a \\
 B' \rightarrow b \\
 C' \rightarrow c
 \end{array}$$

2)  $S \rightarrow A \mid CB$       Term | Prev  
 $A \rightarrow C \mid D$        $\{\epsilon, B, C, D\}$   
 $B \rightarrow b \mid B \mid b$        $\{\epsilon, A, B, C, D\}$        $\{\epsilon, B, C, D\}$   
 $C \rightarrow CC \mid C$        $\{\epsilon, A, B, C, D\}$        $\{\epsilon, A, B, C, D\}$   
 $D \rightarrow dD \mid d$

$S \rightarrow CC \mid C \mid dD \mid d \mid CB$   
 $A \rightarrow CC \mid C \mid dD \mid d$   
 $B \rightarrow bB \mid b$   
 $C \rightarrow CC \mid C$   
 $D \rightarrow dD \mid d$

chain ( $S$ ) =  $\{\epsilon, A, C, D\}$   
 chain ( $A$ ) =  $\{\epsilon, A, C, D\}$   
 chain ( $B$ ) =  $\{\epsilon, B\}$   
 chain ( $C$ ) =  $\{\epsilon, C\}$   
 chain ( $D$ ) =  $\{\epsilon, D\}$

No useless symbols ?

Term	Prev
$\{\epsilon, A, B, C, D\}$	

abbb

	1	2	3	4
1	EA3	ES,X3	Ø	Ø
2		EB3	Ø	Ø
3			EB3	Ø
4				EB3

	1	2	3	4	5
1	EA3	Ø			
2		EA3	ES,X3		
3			EB3	Ø	
4				EB3	Ø
5					EB3

aabbb

4)  $S \rightarrow A|C$

$A \rightarrow AaB|AaC|B|a$

$B \rightarrow Bb|Cb$

$C \rightarrow cC|C$

$S \rightarrow AaB|AaC|B|a$

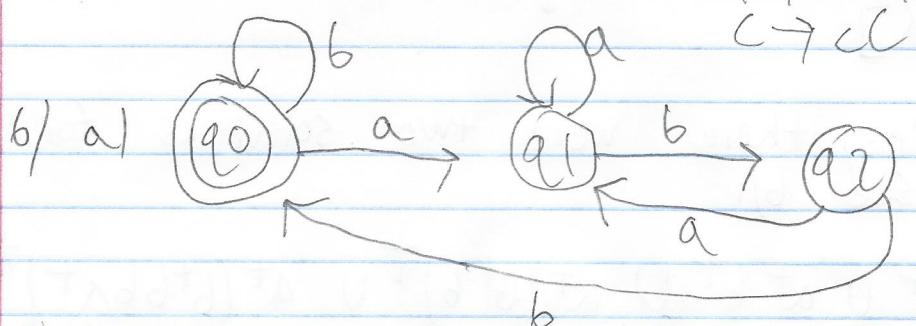
$A \rightarrow BX|ax|B|a$

$X \rightarrow abX|acX|ab|ac$

$B \rightarrow CbY|Cb$

$Y \rightarrow bY|b$

$C \rightarrow cc|c$



b) a) [q0, babaab]

[q0, abaab]

[q1, baab]

[q2, aab]

[q1, ab]

[q1, b]

[q2, X]

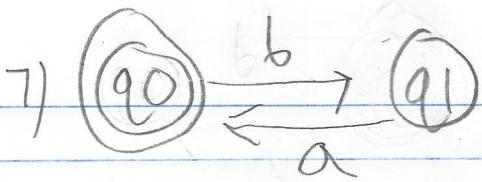
c)  $b^*(a+b(a+b)^*b^+)^*$

d)  $b^*U(b^*a^+)^*$

$b^*(a+b(a+b)^*b^+)^*U$

$b^*a^+(b(a+b)^*b^+a^+)^*$





8) a) S | a | b

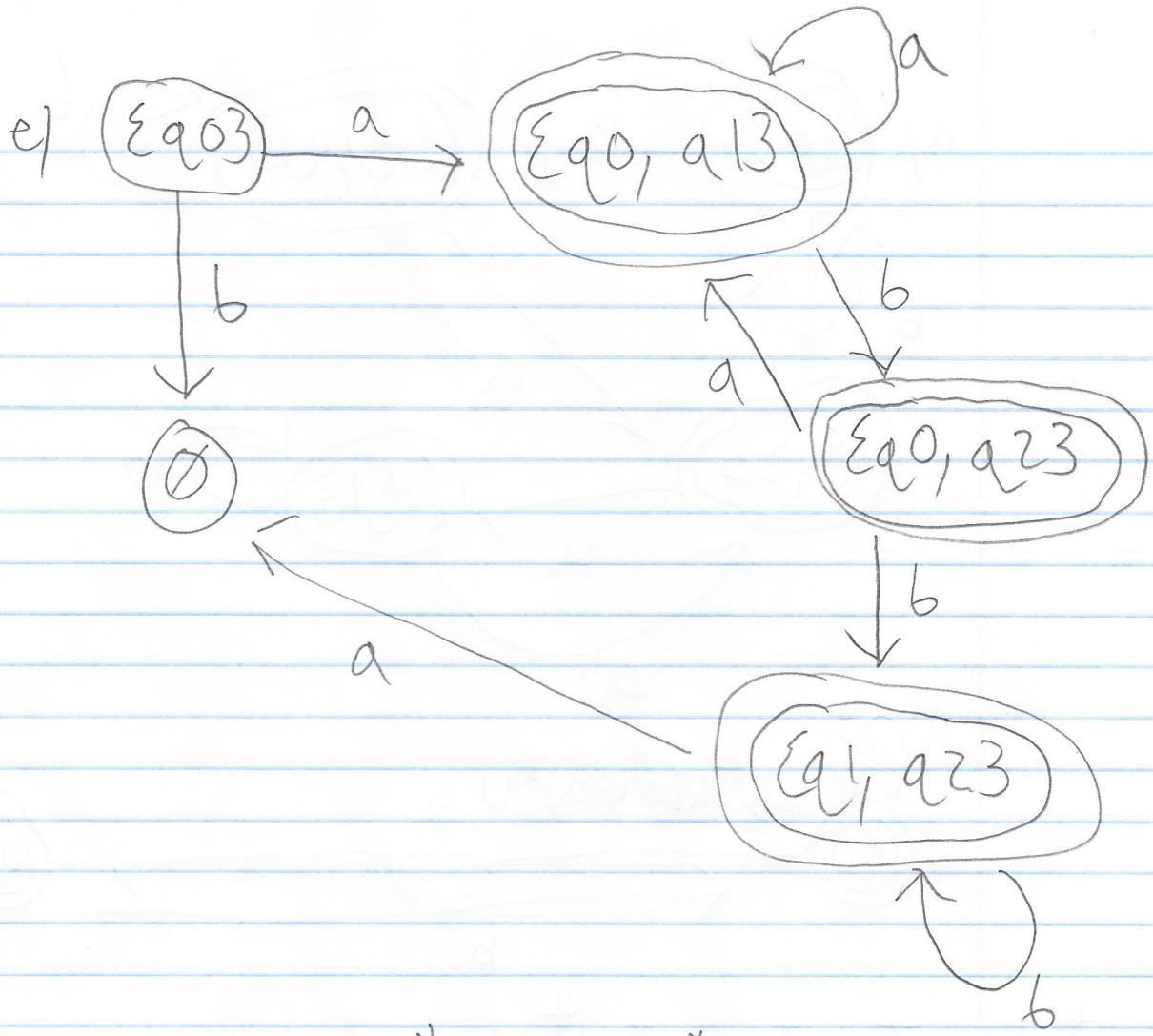
<u>q0</u>	<u><math>\{q0, q1\}</math></u>	<u><math>\emptyset</math></u>
<u>q1</u>	<u><math>\emptyset</math></u>	<u><math>\{q0, q2\}</math></u>
<u>q2</u>	<u><math>\emptyset</math></u>	<u><math>\{q1, q2\}</math></u>

b)  $\{q0, aabb\}$     $\{q0, aabb\}$     $\{q0, aabb\}$     $\{q0, aabb\}$   
 $\{q1, aabb\}$     $\{q0, abbb\}$     $\{q0, abbb\}$     $\{q0, abbb\}$   
 $\{q0, bb\}$     $\{q1, bb\}$     $\{q1, bb\}$     $\{q1, bb\}$   
 $\{q2, b\}$     $\{q2, b\}$     $\{q0, b\}$

$\{q0, aabb\}$   
 $\{q0, abbb\}$   
 $\{q1, bb\}$   
 $\{q2, b\}$   
 $\{q2, \lambda\}$

c) Yes, there were two solutions for aabb.  
 See b).

d)  $a^+ \cup a^+ b^+ \cup a^+ (b^+ b)^* \cup a^+ (b^+ b b a^+)^*$

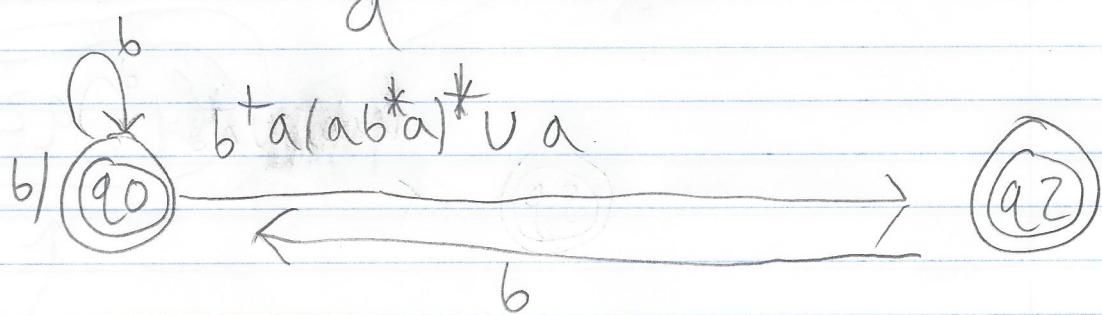
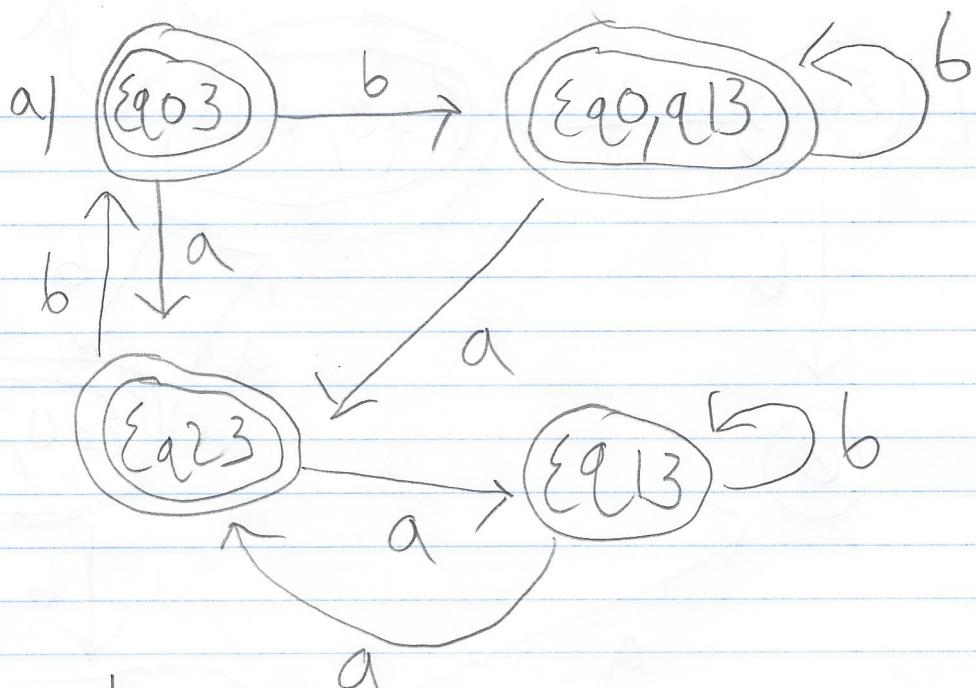


f)  $(a^+)^* \cup (a^+ b)^* \cup (a^+ b^+)^* \cup (a^+ b^+ b)^*$

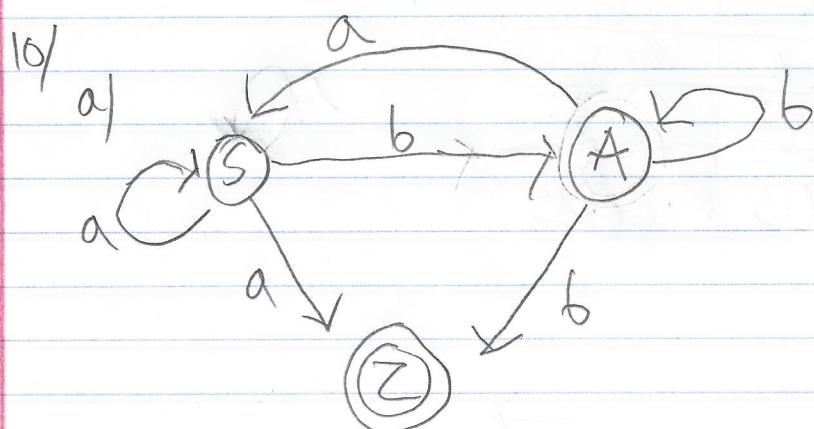
g)

S	a	b
q0	q23	q0, q13
q1	q23	q13
q2	q13	q03

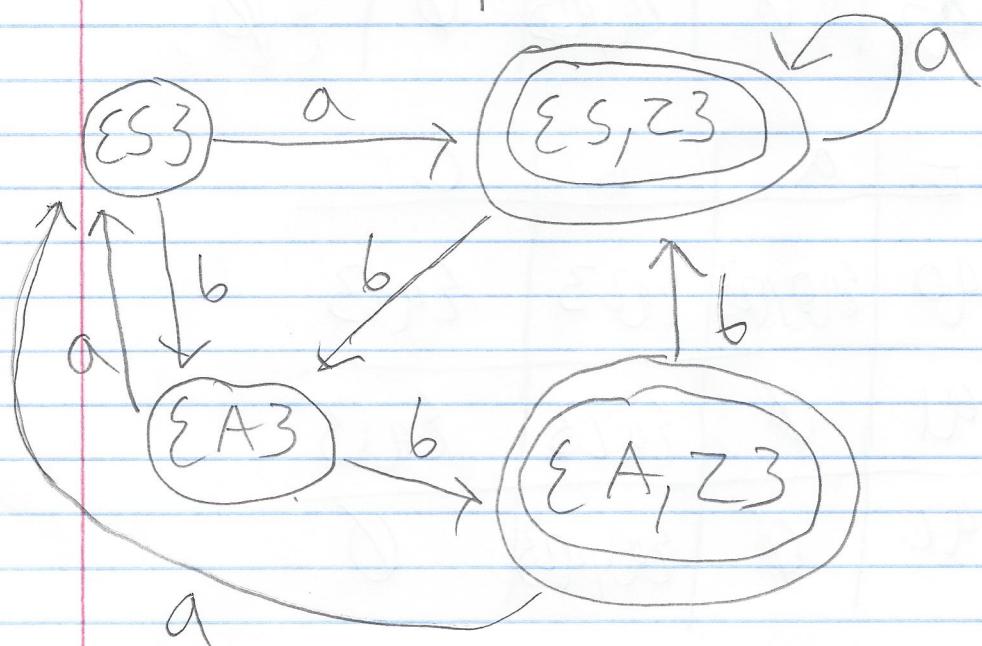




$$b^* \cup b^* (b^* a (ab^* a)^* \cup a) b^* \cup$$

$$b^* (b^* a (ab^* a)^* \cup a) (b^* (b^* a (ab^* a)^* \cup a) b^*)^*$$


b	8	a	b
S	ES, Z3	EA 3	
A	ES3	EA, Z3	
Z	∅	∅	



d)

q	S → aS   bA   aZ
S → aS   bA   bZ	
Z → λ	

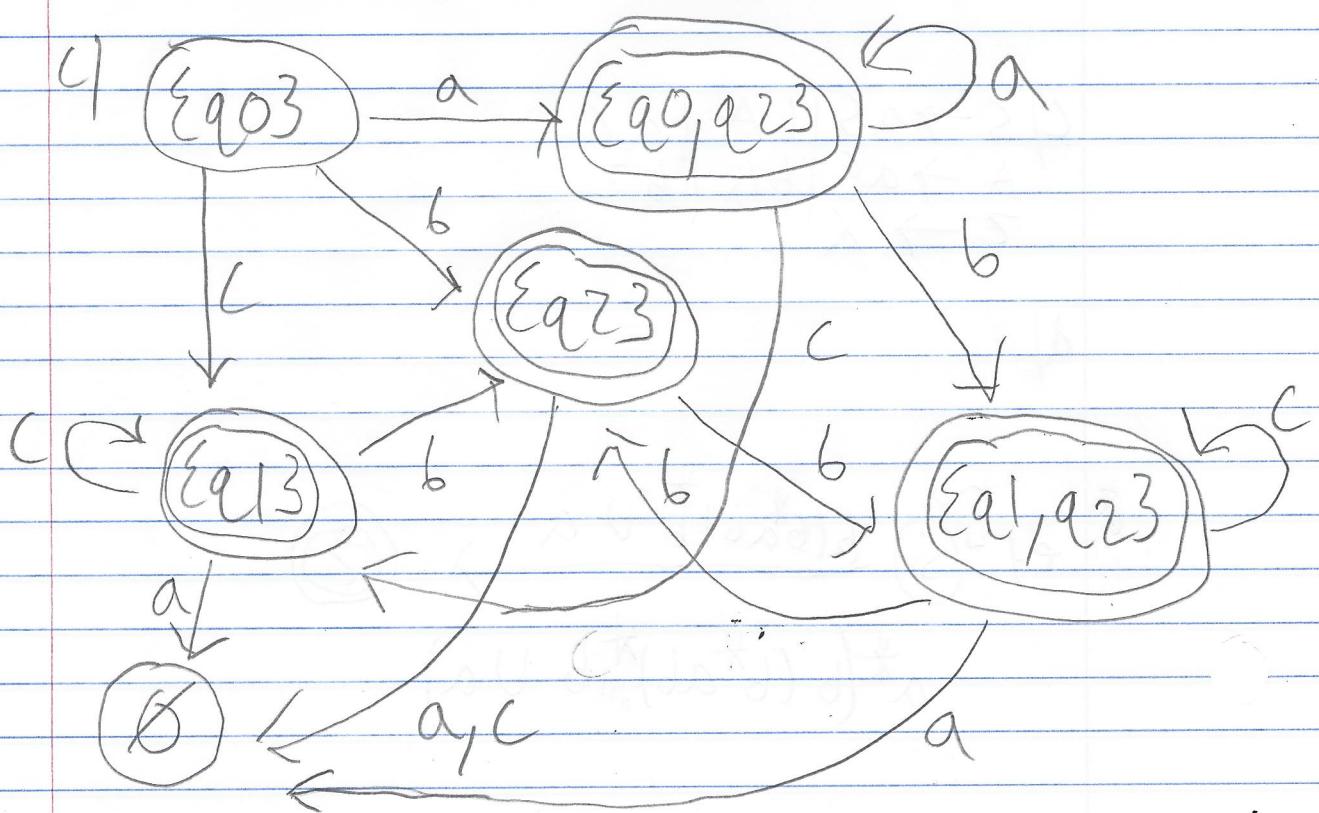
e)

$\text{S} \xrightarrow{a} \text{S}$     $b(b^*ab)^*b \vee a \xrightarrow{} \text{Z}$

$$a^*(b(b^*ab)^*b \vee a)$$

$\text{W/a}$	$s$	$a$	$b$	$c$	$\lambda$
$q_0$	$\{\text{a}\}$	$\emptyset$	$\{\text{a}\}$	$\{\text{a}, \text{b}\}$	$\{\text{a}, \text{b}, \text{c}\}$
$q_1$	$\emptyset$	$\{\text{a}, \text{b}\}$	$\{\text{a}\}$	$\{\text{a}\}$	$\emptyset$
$q_2$	$\emptyset$	$\{\text{a}, \text{b}, \text{c}\}$	$\emptyset$	$\emptyset$	$\{\text{a}\}$

$b/t$	$a$	$b$	$c$
$q_0$	$\{\text{a}, \text{b}\}$	$\{\text{b}\}$	$\{\text{a}\}$
$q_1$	$\emptyset$	$\{\text{b}\}$	$\{\text{a}\}$
$q_2$	$\emptyset$	$\{\text{a}, \text{b}\}$	$\emptyset$



d)  $a^*b^* \cup a^*c^* \cup a^*b^+c^*$

12)